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**Whitney et al.**

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(54) **METHOD AND SYSTEM OF HIERARCHICAL METADATA MANAGEMENT AND APPLICATION**

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(22) Filed: **Dec. 5, 2011**

(65) **Prior Publication Data**

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(51) **Int. Cl.**
***G06F 17/30*** (2006.01)

(52) **U.S. Cl.**
CPC ..... ***G06F 17/30997*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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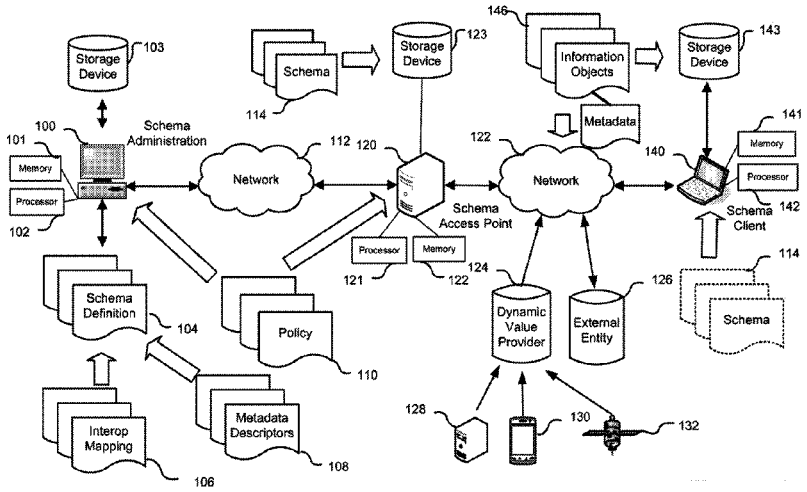
(74) *Attorney, Agent, or Firm* — Byrne Poh LLP

(57) **ABSTRACT**

A method of metadata management is provided. Metadata associated with information objects is important in the management and classification of electronic information referred to as information objects. A metadata schema structure definition is defined enabling a metadata schema to be applied to the information objects to ensure consistent creation and management of hierarchical metadata across and organization and interoperability between different metadata schemas.

**50 Claims, 28 Drawing Sheets**



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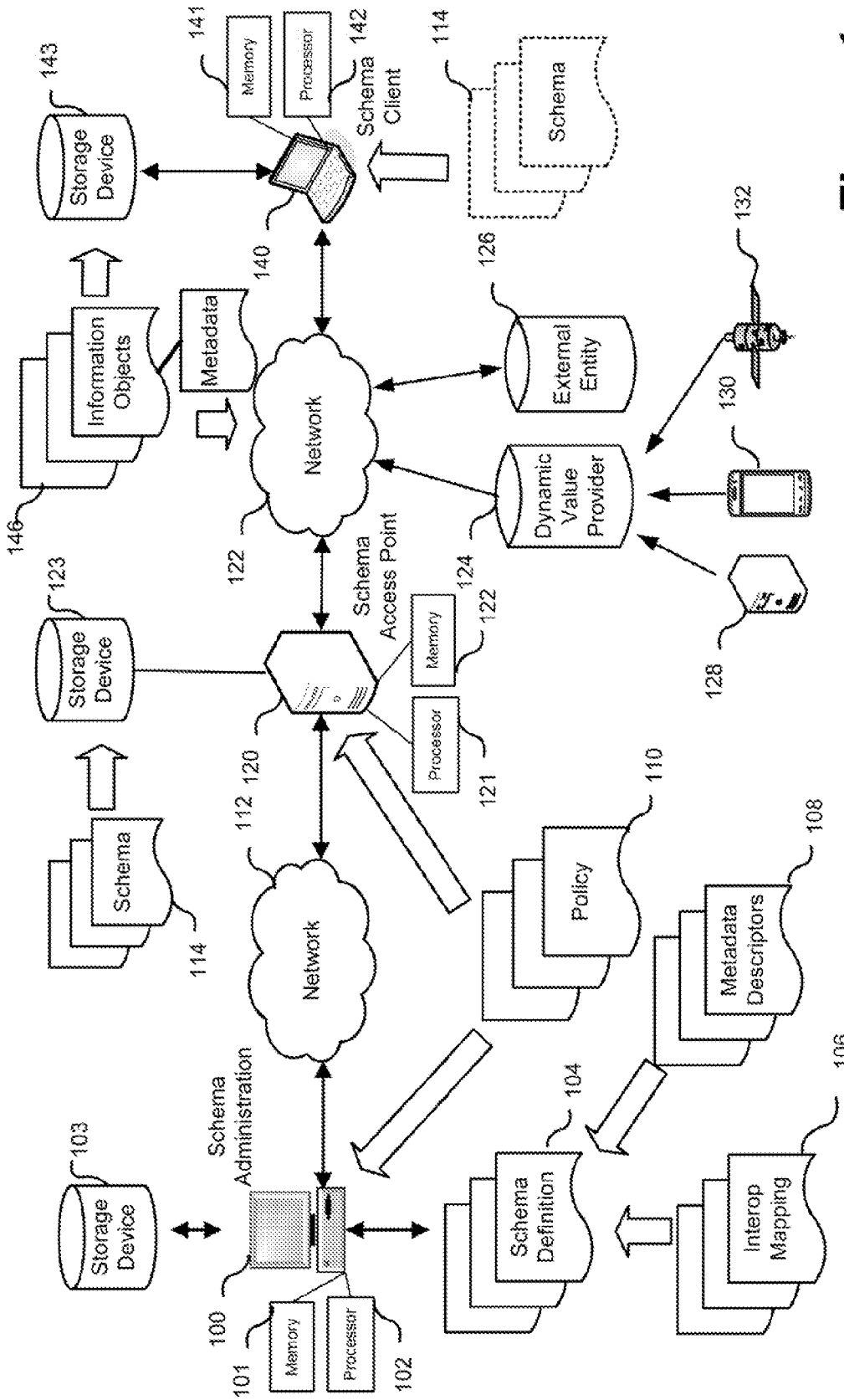
Storage Device
143
Memory
141
Processor
142
Schema Client
114
Schema
140
Information Objects
Metadata
146
Network
122
External Entity
126
132
130
Dynamic Value Provider
128
Schema Access Point
Storage Device
123
Memory
124
122
Processor
121
120
112
Schema
114
Network
Policy
110
Metadata Descriptors
108
Schema Administration
Storage Device
103
Schema Definition
104
Interop Mapping
106
100
Memory
101
Processor
102

Figure 1

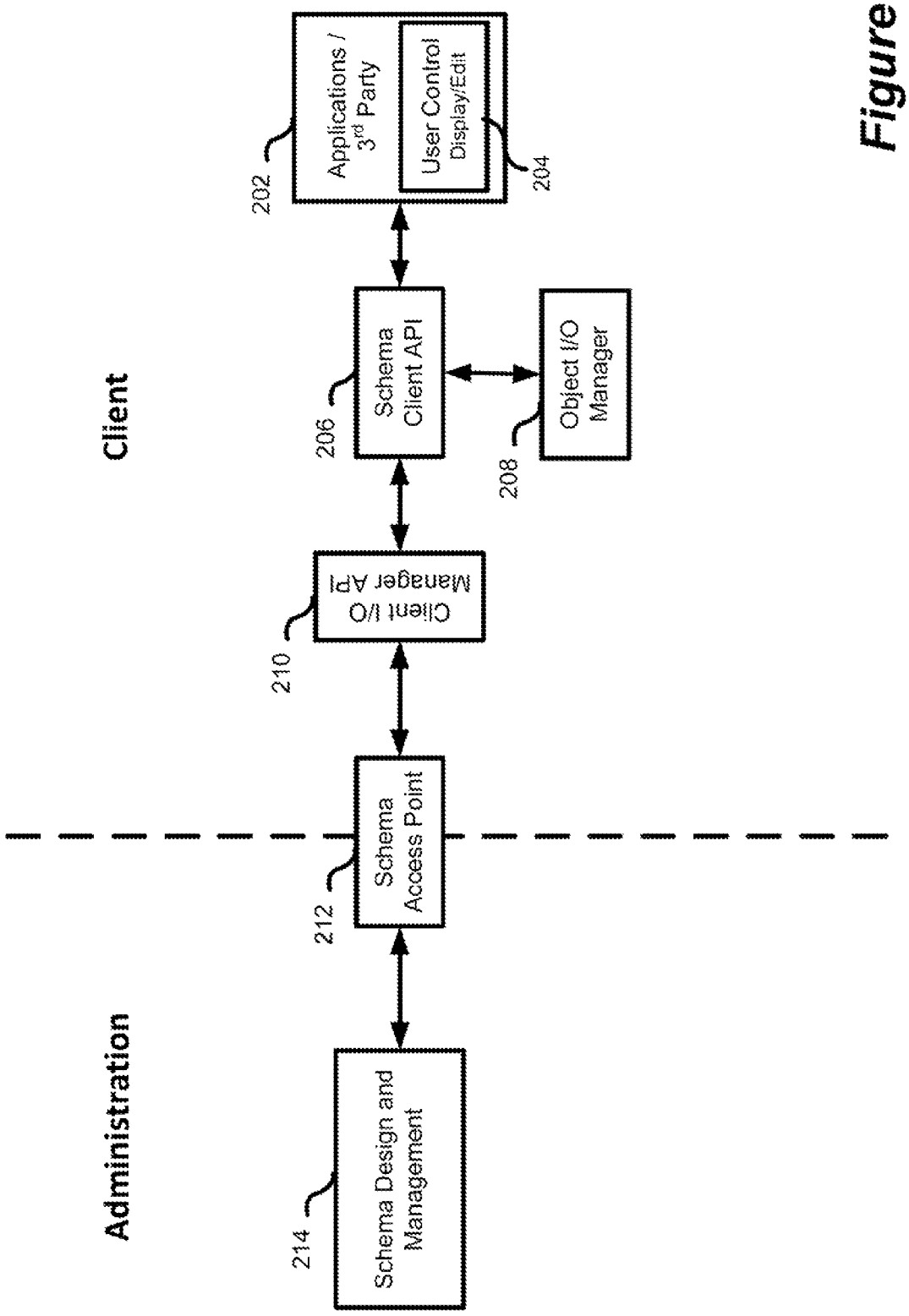
Client
Administration
Applications / 3rd Party
User Control Display/Edit
202
204
Schema Client API
206
Object I/O Manager
208
Client I/O Manager API
210
Schema Access Point
212
Schema Design and Management
214

Figure 2

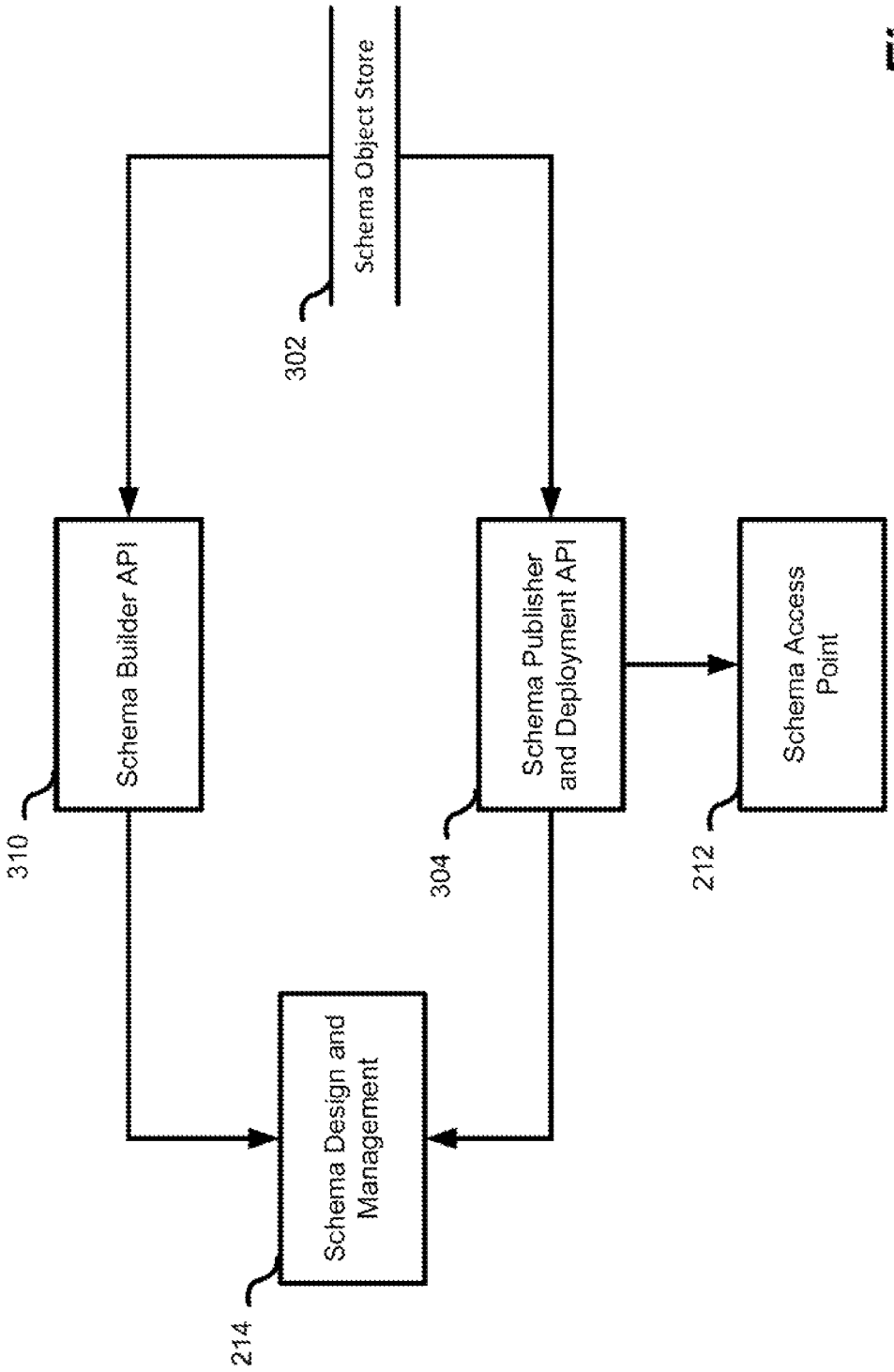
Schema Object Store
302
Schema Builder API
310
Schema Publisher and Deployment API
304
Schema Access Point
212
Schema Design and Management
214

Figure 3

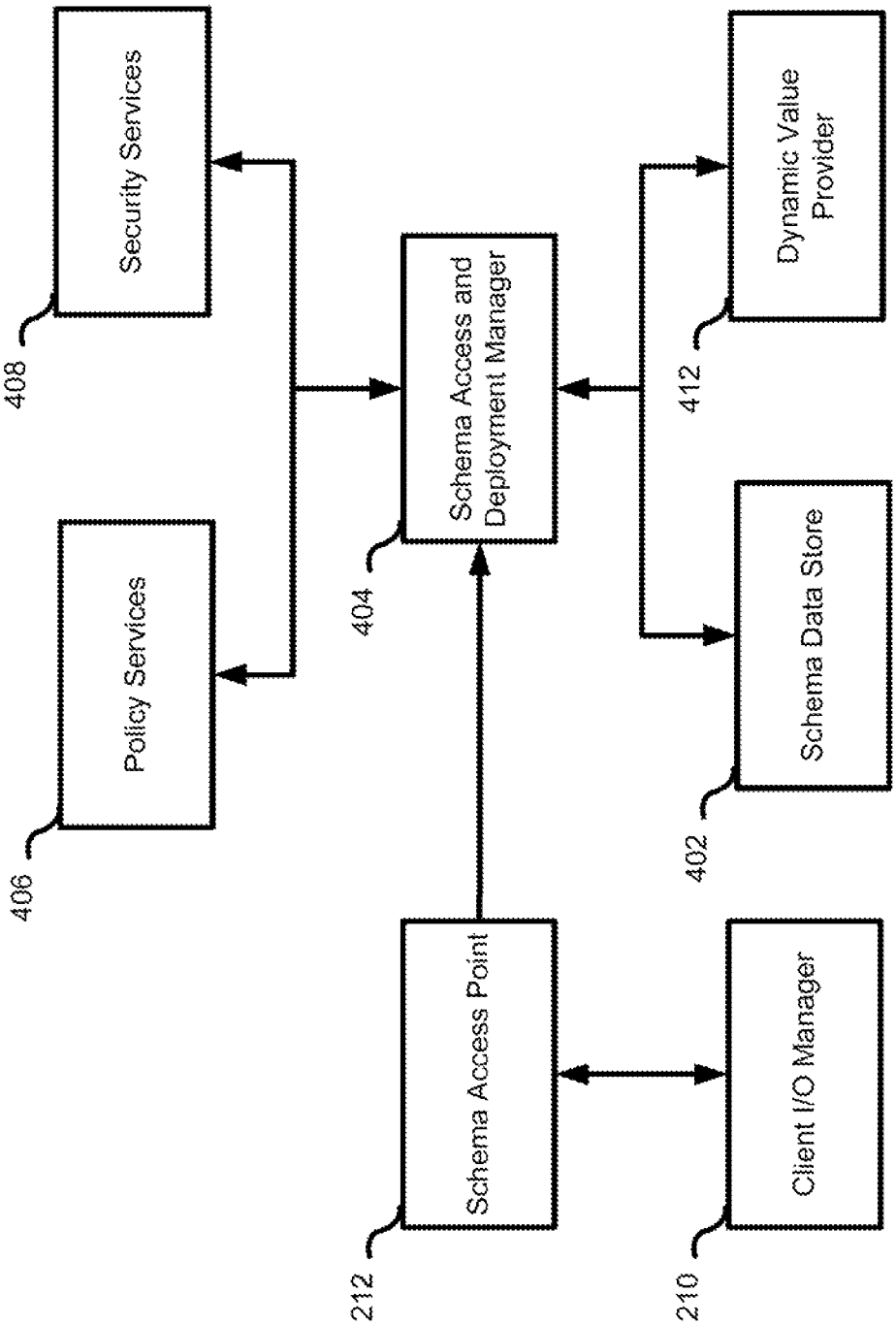
Security Services
408
Policy Services
406
Schema Access and Deployment Manager
404
Dynamic Value Provider
412
Schema Data Store
402
Schema Access Point
212
Client I/O Manager
210

Figure 4

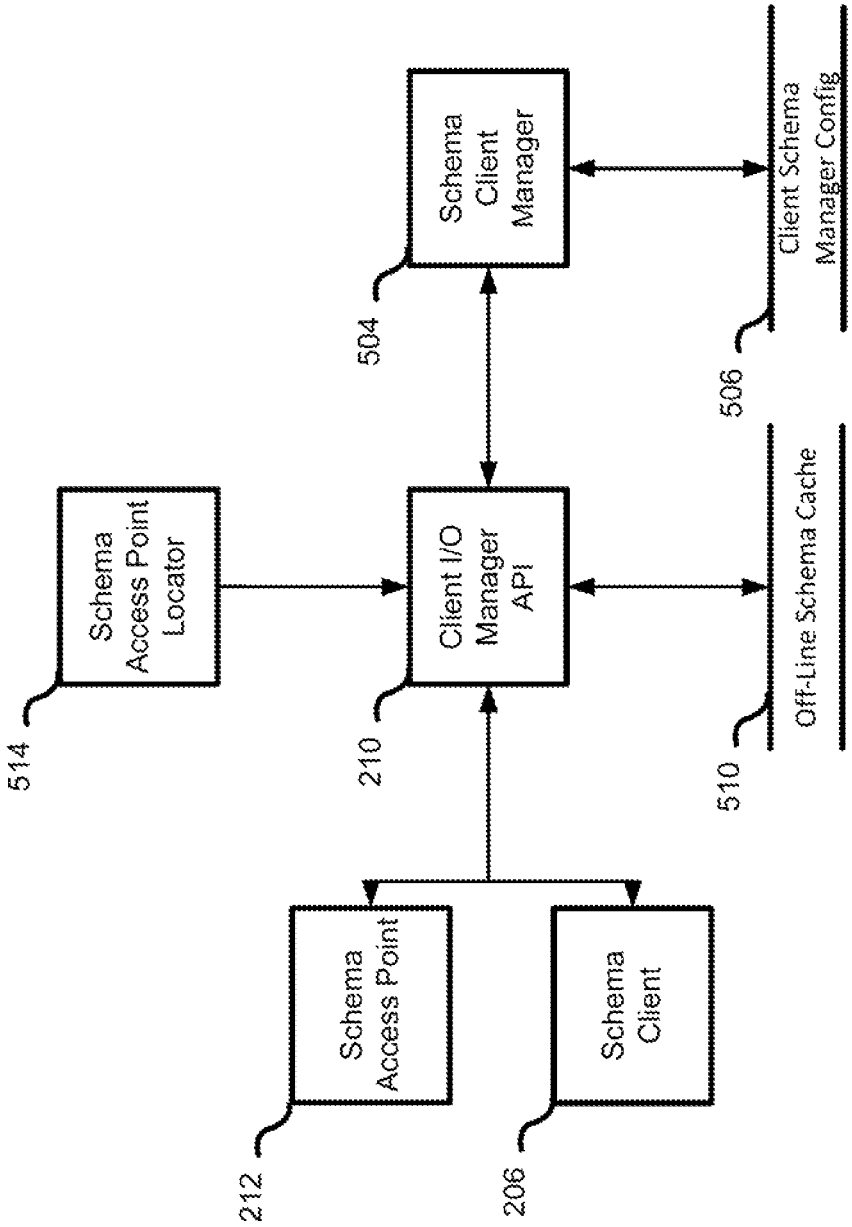
Schema Client Manager
504
Client Schema Manager Config
506
Schema Access Point Locator
514
Client I/O Manager API
210
Off-Line Schema Cache
510
Schema Access Point
212
Schema Client
206

Figure 5

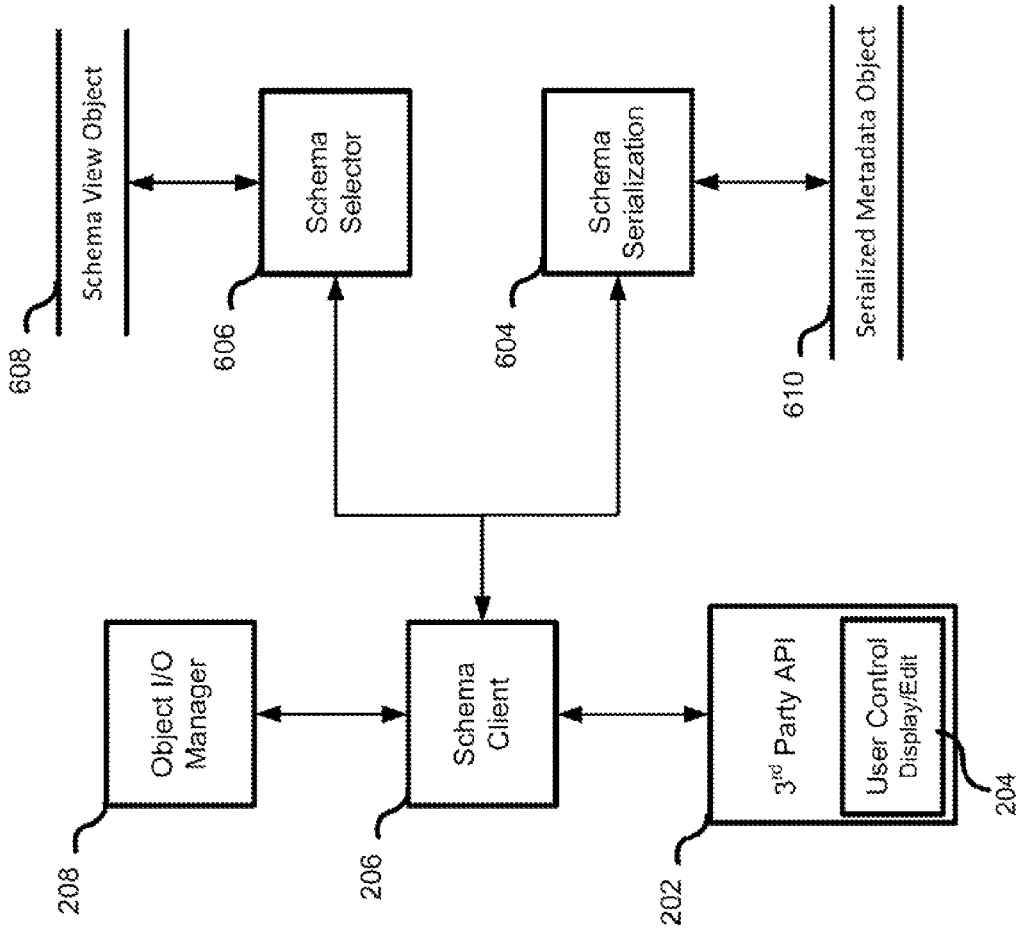
Schema View Object
608
Schema Selector
606
Schema Serialization
604
Serialized Metadata Object
610
Object I/O Manager
208
Schema Client
206
3rd Party API
User Control Display/Edit
202
204

Figure 6

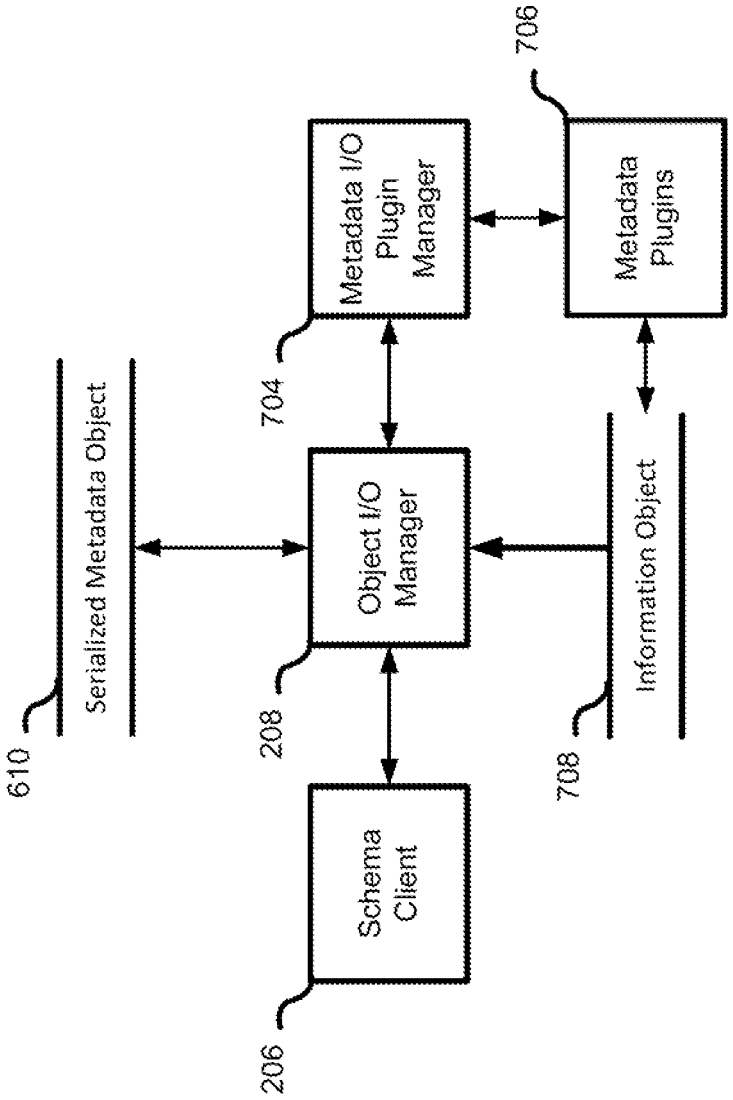
Schema Client
206
Object I/O Manager
208
Metadata I/O Plugin Manager
704
Metadata Plugins
706
Serialized Metadata Object
610
Information Object
708

Figure 7

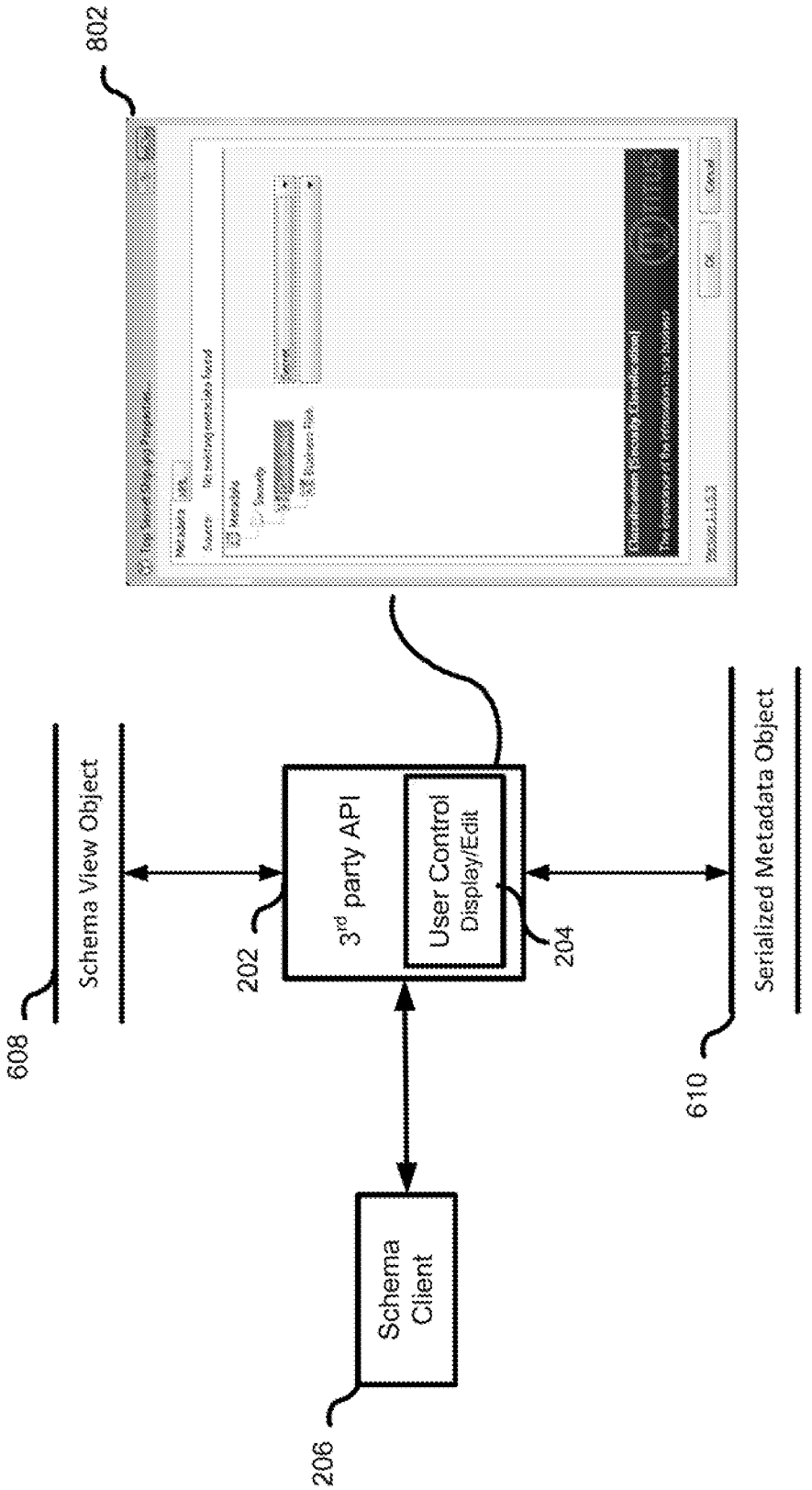
802
Schema View Object
608
3rd party API
User Control
Display/Edit
202
204
Serialized Metadata Object
610
Schema
Client
206

Figure 8

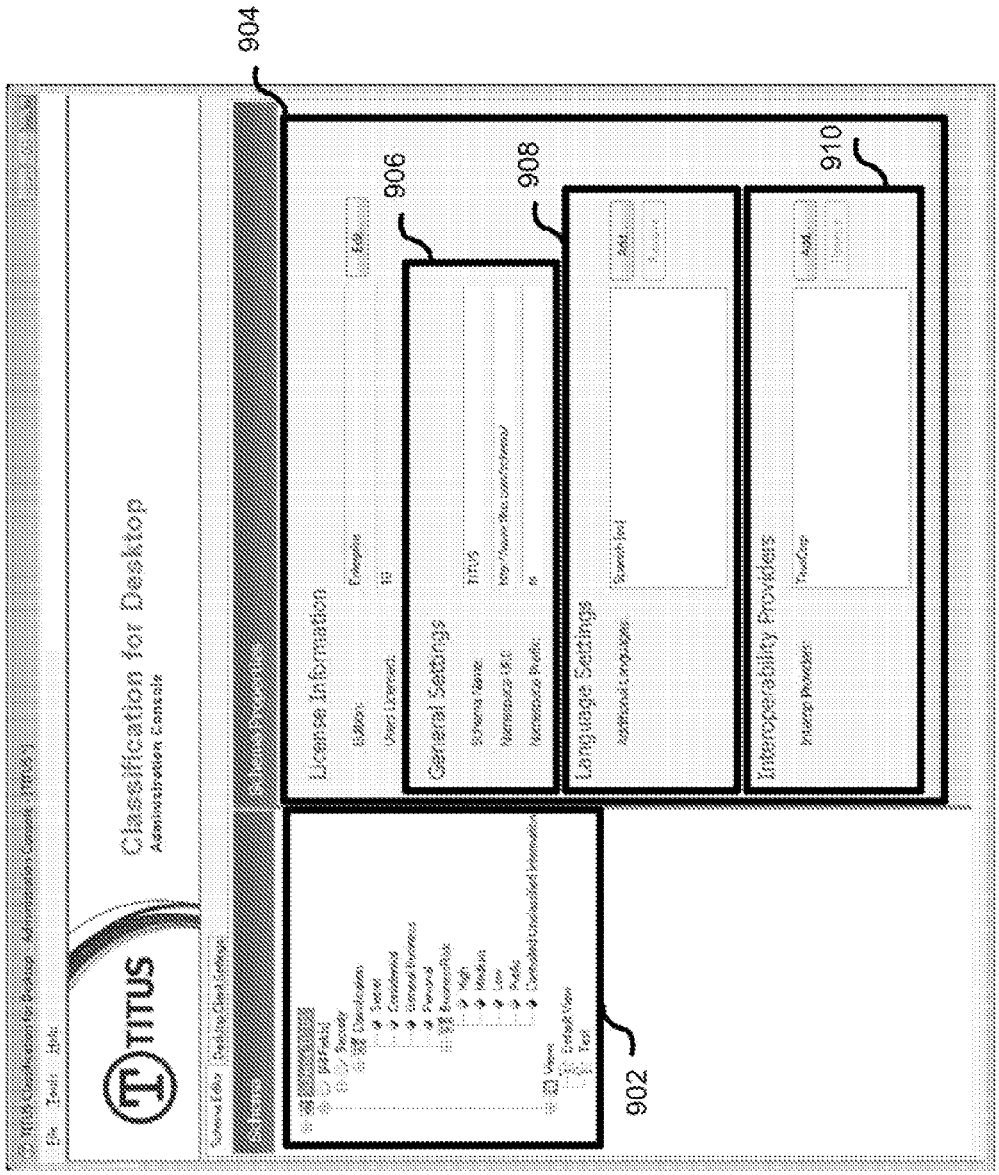
TITUS
Classification for Desktop
Administration Console
License Information
General Settings
Language Settings
Interoperability Providers
902
904
906
908
910

Figure 9

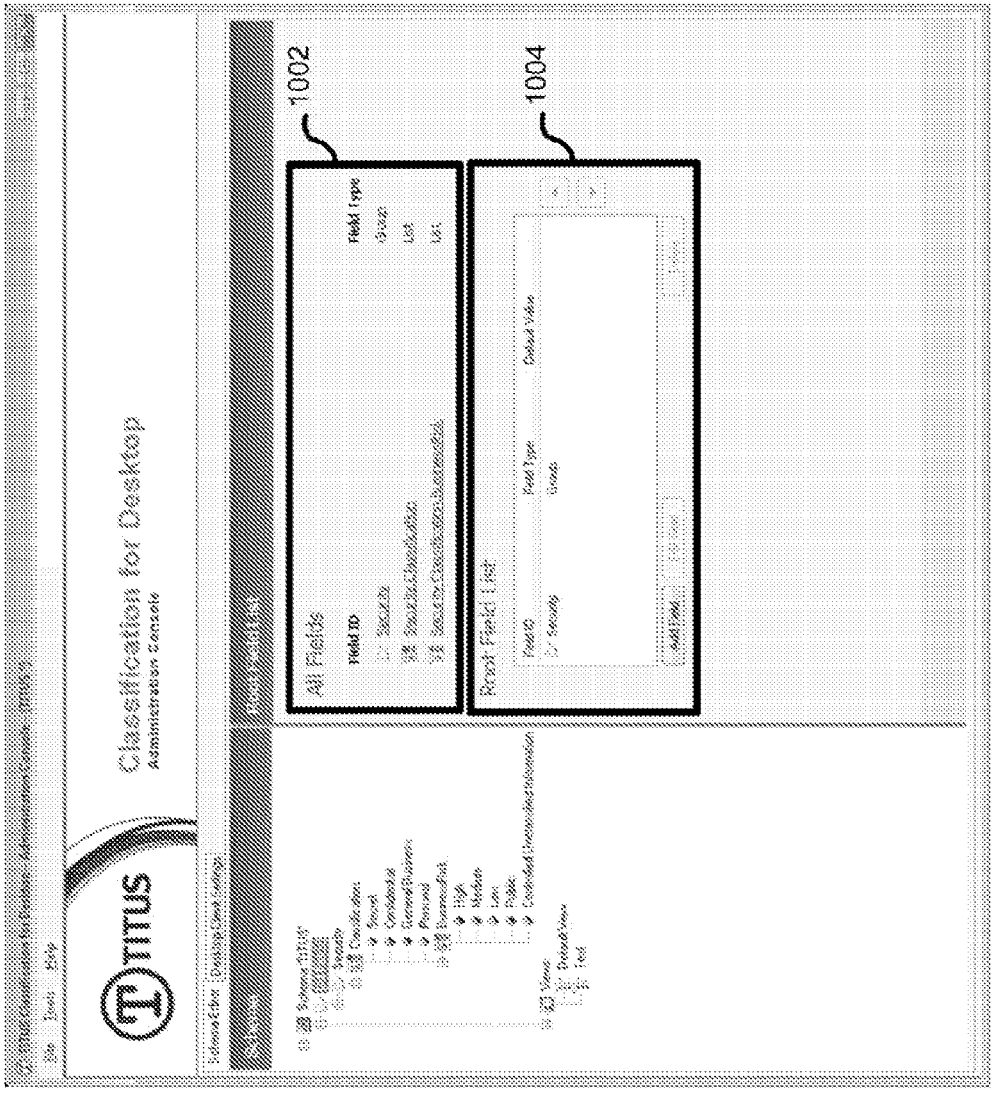
TITUS
Classification for Desktop
Administration Console
1002
1004

Figure 10

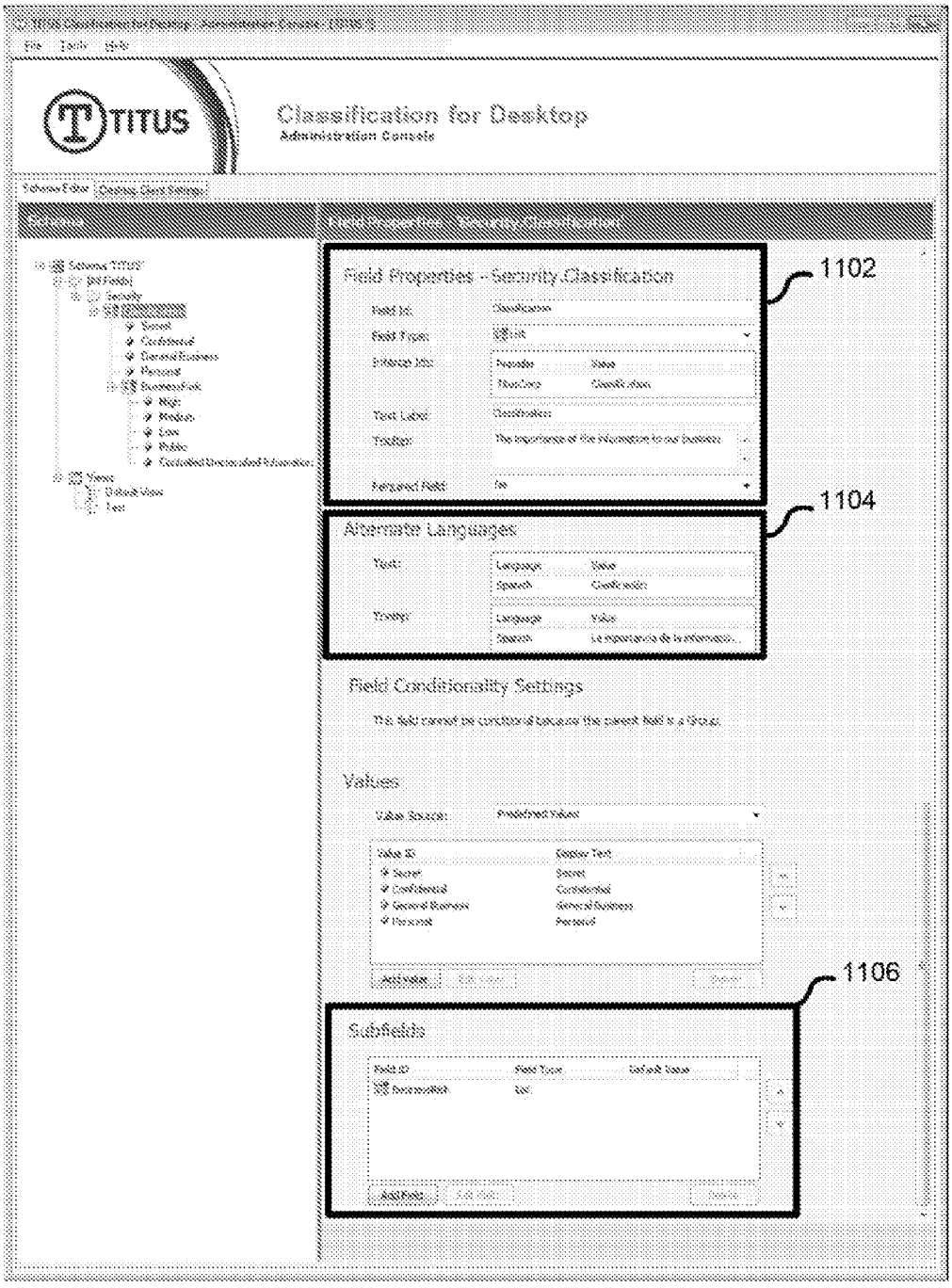
TITUS
Classification for Desktop
Administration Console
Field Properties - Security Classification
1102
Alternate Languages
1104
Field Conditionality Settings
Values
1106
Subfields

Figure 11

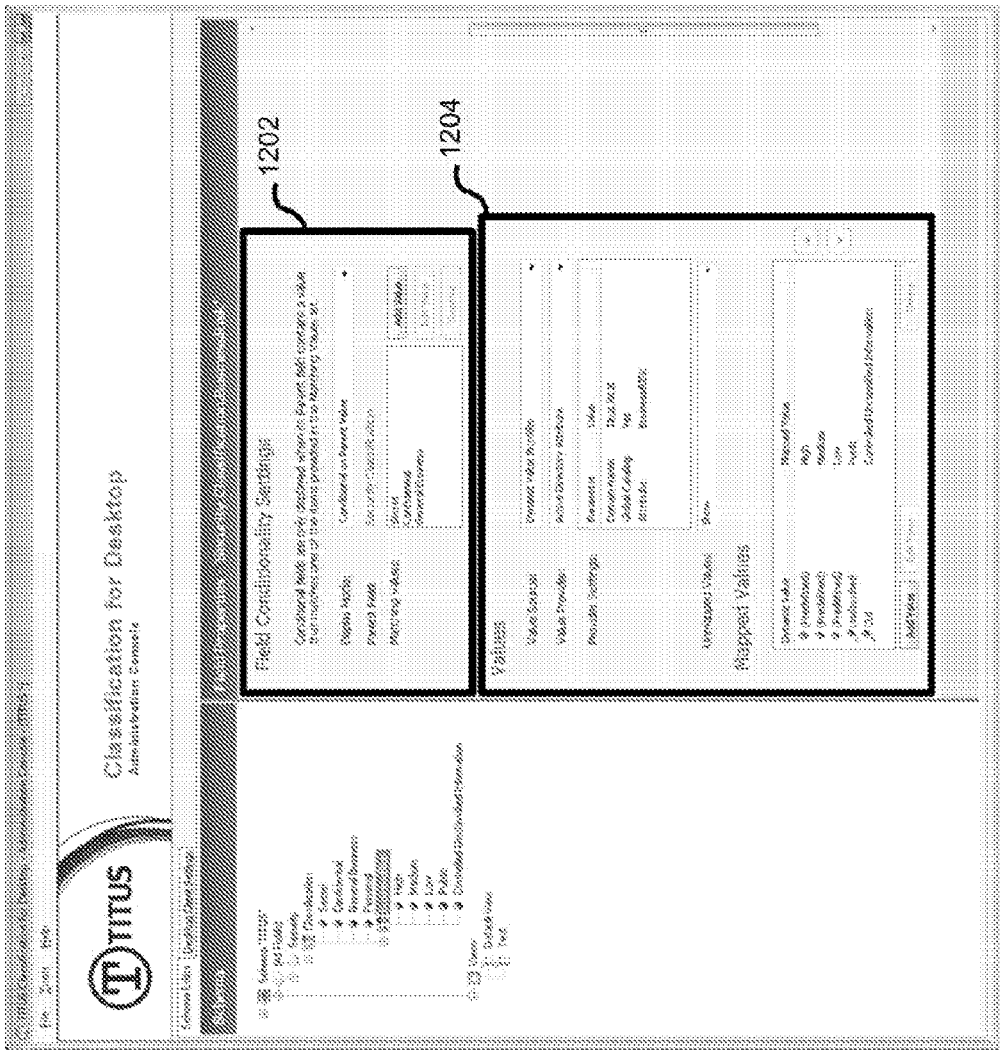
TITUS
Classification for Desktop
Administration Console
Field Conditionality Settings
1202
1204
Values
Mapped Values

Figure 12

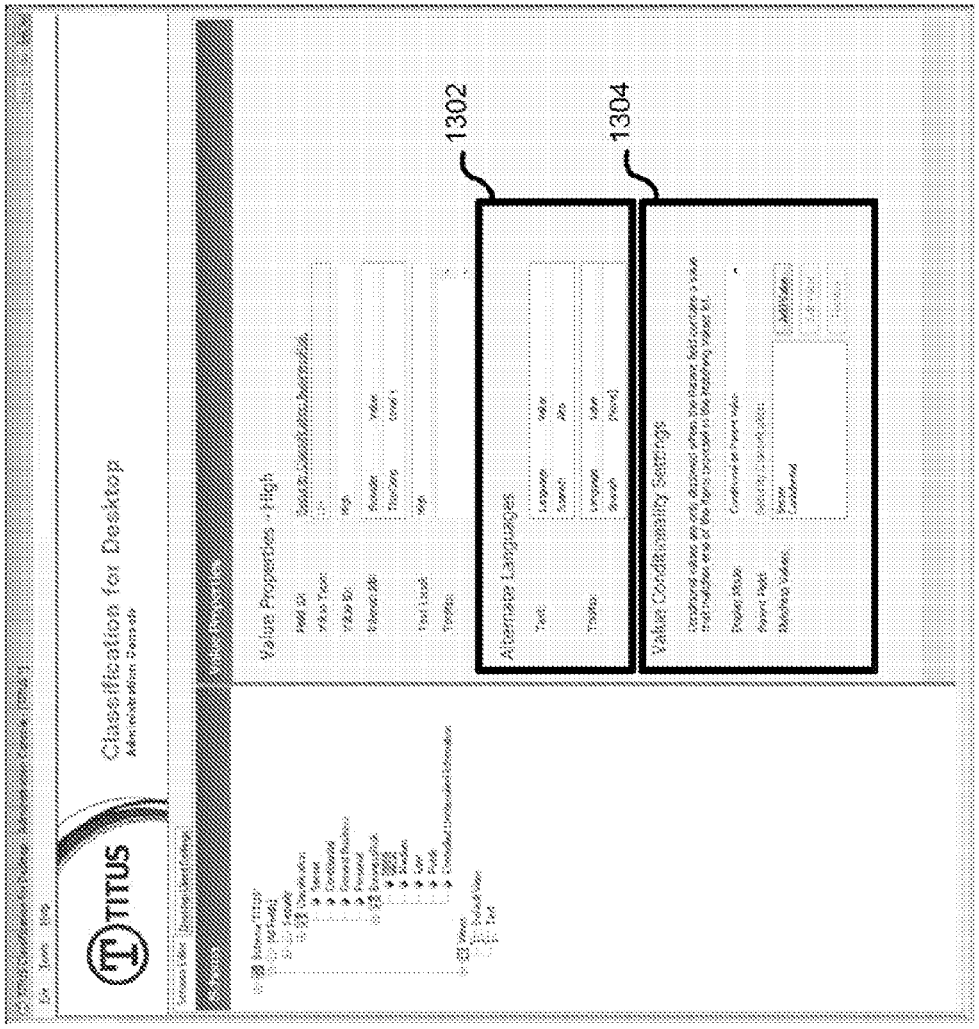
TITUS
Classification for Desktop
Value Properties - High
Alternate Languages
Value Conditionality Settings
1302
1304

Figure 13

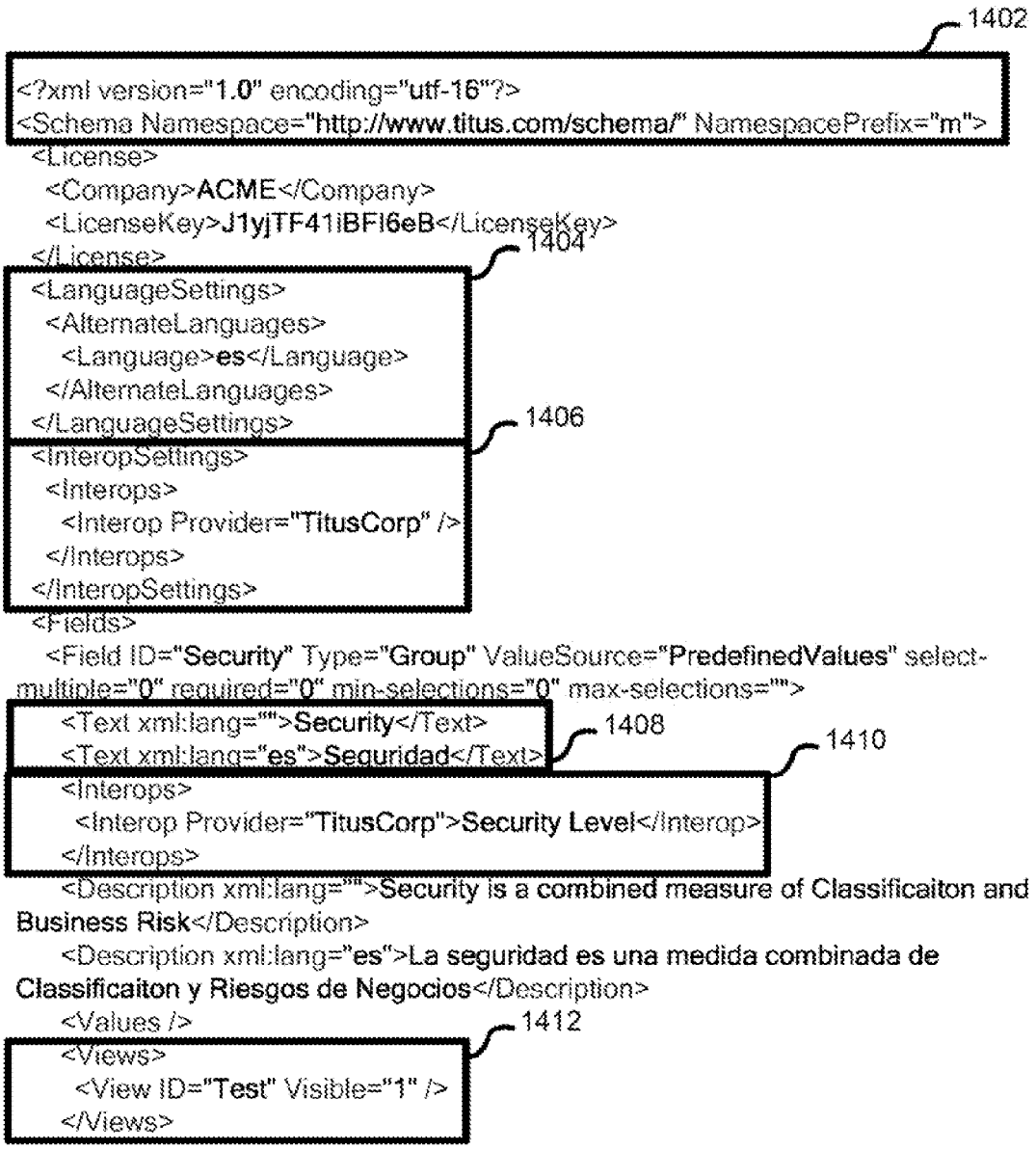
1402
<?xml version="1.0" encoding="utf-16"?>
<Schema Namespace="http://www.titus.com/schema/" NamespacePrefix="m">
<License>
<Company>ACME</Company>
<LicenseKey>J1yjTF41iBFI6eB</LicenseKey>
</License>
1404
<LanguageSettings>
<AlternateLanguages>
<Language>es</Language>
</AlternateLanguages>
</LanguageSettings>
1406
<InteropSettings>
<Interops>
<Interop Provider="TitusCorp" />
</Interops>
</InteropSettings>
<Fields>
<Field ID="Security" Type="Group" ValueSource="PredefinedValues" select-multiple="0" required="0" min-selections="0" max-selections="">
<Text xml:lang="">Security</Text>
<Text xml:lang="es">Seguridad</Text>
1408
1410
<Interops>
<Interop Provider="TitusCorp">Security Level</Interop>
</Interops>
<Description xml:lang="">Security is a combined measure of Classificaiton and Business Risk</Description>
<Description xml:lang="es">La seguridad es una medida combinada de Classificaiton y Riesgos de Negocios</Description>
<Values />
1412
<Views>
<View ID="Test" Visible="1" />
</Views>

*Figure 14*

```
<Conditional Mode="Default" />
  <Fields>
   <Field ID="Classification" Type="List" ValueSource="PredefinedValues" select-multiple="0"
required="0" min-selections="0" max-selections="">
    <Text xml:lang="">Classification</Text>
    <Text xml:lang="es">Clasificación</Text>
    <Interops>
     <Interop Provider="TitusCorp">Classification</Interop>
    </Interops>
    <Description xml:lang="">The importance of the information to our business</Description>
    <Description xml:lang="es">La importancia de la información para nuestro negocio</
Description>
    <Values>
     <Value ID="Secret">
      <Text xml:lang="">Secret</Text>
      <Text xml:lang="es">Secreto</Text>
      <Desc xml:lang=""></Desc>
      <Desc xml:lang="es"></Desc>
      <Interops>
       <Interop Provider="TitusCorp">Classified High</Interop>
      </Interops>
      <Conditional Mode="Default" />
     </Value>
     <Value ID="Confidential">
      <Text xml:lang="">Confidential</Text>
      <Text xml:lang="es">Confidencial</Text>
      <Desc xml:lang=""></Desc>
      <Desc xml:lang="es"></Desc>
      <Interops>
       <Interop Provider="TitusCorp">Classified Medium</Interop>
      </Interops>
      <Conditional Mode="Default" />
     </Value>
     <Value ID="General Business">
      <Text xml:lang="">General Business</Text>
      <Text xml:lang="es">General de Negocios</Text>
      <Desc xml:lang=""></Desc>
      <Desc xml:lang="es"></Desc>
      <Interops>
       <Interop Provider="TitusCorp">Classified Low</Interop>
      </Interops>
      <Conditional Mode="Default" />
     </Value>
     <Value ID="Personal">
      <Text xml:lang="">Personal</Text>
      <Text xml:lang="es">Personal</Text>
      <Desc xml:lang=""></Desc>
      <Desc xml:lang="es"></Desc>
      <Interops>
       <Interop Provider="TitusCorp">Unclassified</Interop>
      </Interops>
      <Conditional Mode="Default" />
     </Value>
    </Values>
    <Views>
     <View ID="Test" Visible="1" />
    </Views>
    <Conditional Mode="Default" />
    <Fields>
```

Figure 14a

```
<Field ID="BussinessRisk" Type="List"
ValueSource="DynamicValueProvider" select-multiple="0" required="0"
min-selections="0" max-selections="">
        <Text xml:lang="">Bussiness Risk</Text>
        <Text xml:lang="es">Riesgos del Negocio</Text>
        <Interops>
         <Interop Provider="TitusCorp">BusinessRisk</Interop>
        </Interops>
        <Description xml:lang="">Risk to the business is this
information is improperly disclosed</Description>
        <Description xml:lang="es">Riesgo para el negocio es esta
información se divulguen indebidamente</Description>
        <DynamicValueProvider ID="AD"
DynamicValueIDSource="MappedValue" IncludeUnmapped="1">
  <Mappings>
          <DynamicMapping Static="1" MappedValue="High" />
          <DynamicMapping Static="1" MappedValue="Medium" />
          <DynamicMapping Static="1" MappedValue="Low" />
          <DynamicMapping DynamicValue="Unclassified"
MappedValue="Public" />
          <DynamicMapping DynamicValue="CUI"
MappedValue="Controlled Unclassified Information" />
  </Mappings>
        <Param ID="Domain" Value="Titus.local" />
        <Param ID="GlobalCatalog" Value="Yes" />
        <Param ID="Attribute" Value="BusinessRISK" />
       </DynamicValueProvider>
      <Values>
       <Value ID="High">
        <Text xml:lang="">High</Text>
        <Text xml:lang="es">Alto</Text>
        <Desc xml:lang=""></Desc>
        <Desc xml:lang="es"></Desc>
        <Interops>
         <Interop Provider="TitusCorp">Level 1</Interop>
        </Interops>
        <Conditional Mode="ConditionalParentValue">
         <Values>
          <Value>Secret</Value>
          <Value>Confidential</Value>
          <Value />
         </Values>
        </Conditional>
       </Value>
```

1502

1504

*Figure 15*

```
<Value ID="Medium">
 <Text xml:lang="">Medium</Text>
 <Text xml:lang="es">Medio</Text>
 <Desc xml:lang=""></Desc>
 <Desc xml:lang="es"></Desc>
 <Interops>
  <Interop Provider="TitusCorp">Level 2</Interop>
 </Interops>
 <Conditional Mode="ConditionalParentValue">
  <Values>
   <Value>General Business</Value>
   <Value />
  </Values>
 </Conditional>
</Value>
<Value ID="Low">
 <Text xml:lang="">Low</Text>
 <Text xml:lang="es">Bajo</Text>
 <Desc xml:lang=""></Desc>
 <Desc xml:lang="es"></Desc>
 <Interops>
  <Interop Provider="TitusCorp">Level 3</Interop>
 </Interops>
 <Conditional Mode="ConditionalParentValue">
  <Values>
   <Value>General Business</Value>
  </Values>
 </Conditional>
</Value>
```

1502a

*Figure 15a*

```
<Value ID="Public">
            <Text xml:lang="">Public</Text>
            <Text xml:lang="es"></Text>
            <Desc xml:lang=""></Desc>
            <Desc xml:lang="es"></Desc>
            <Interops>
              <Interop Provider="TitusCorp"></Interop>
            </Interops>
            <Conditional Mode="Default" />
          </Value>
          <Value ID="Controlled Unclassified Information">
            <Text xml:lang="">Controlled Unclassified Information</Text>
            <Text xml:lang="es"></Text>
            <Desc xml:lang=""></Desc>
            <Desc xml:lang="es"></Desc>
            <Interops>
              <Interop Provider="TitusCorp"></Interop>
            </Interops>
            <Conditional Mode="Default" />
          </Value>
        </Values>
        <Views>
          <View ID="Test" Visible="0" />
        </Views>
        <Conditional Mode="ConditionalParentValue">
          <Values>
            <Value>Secret</Value>
            <Value>Confidential</Value>
            <Value>General Business</Value>
          </Values>
        </Conditional>
        <Fields />
      </Field>
    </Fields>
  </Field>
 </Fields>
 <ViewSettings>
  <Views>
   <View ID="Test" />
  </Views>
 </ViewSettings>
</Schema>
```

*Figure 15b*

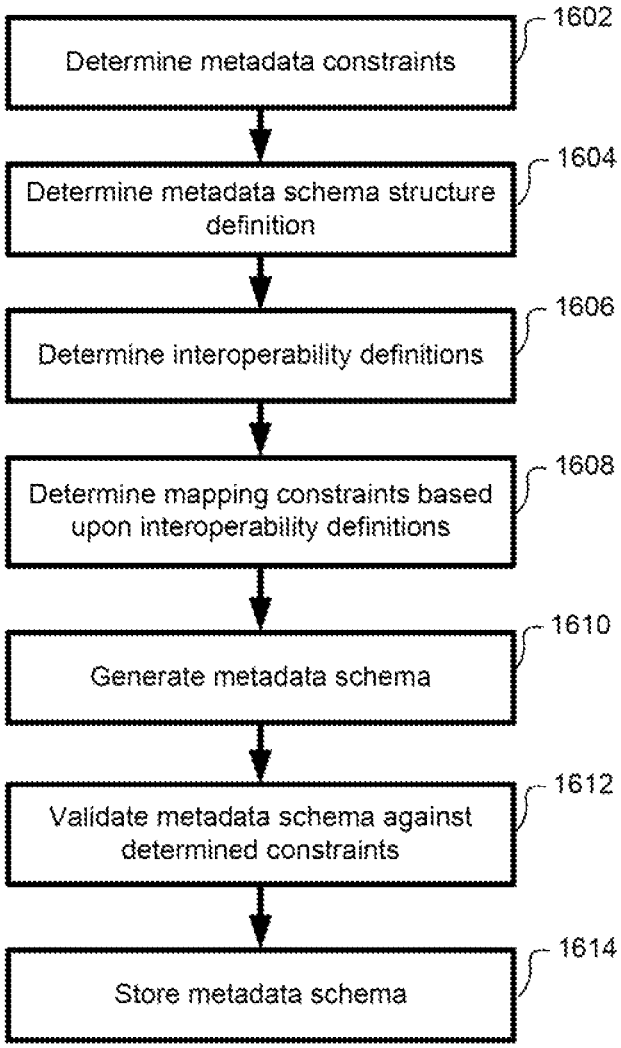
Determine metadata constraints
1602
Determine metadata schema structure definition
1604
Determine interoperability definitions
1606
Determine mapping constraints based upon interoperability definitions
1608
Generate metadata schema
1610
Validate metadata schema against determined constraints
1612
Store metadata schema
1614

*Figure 16*

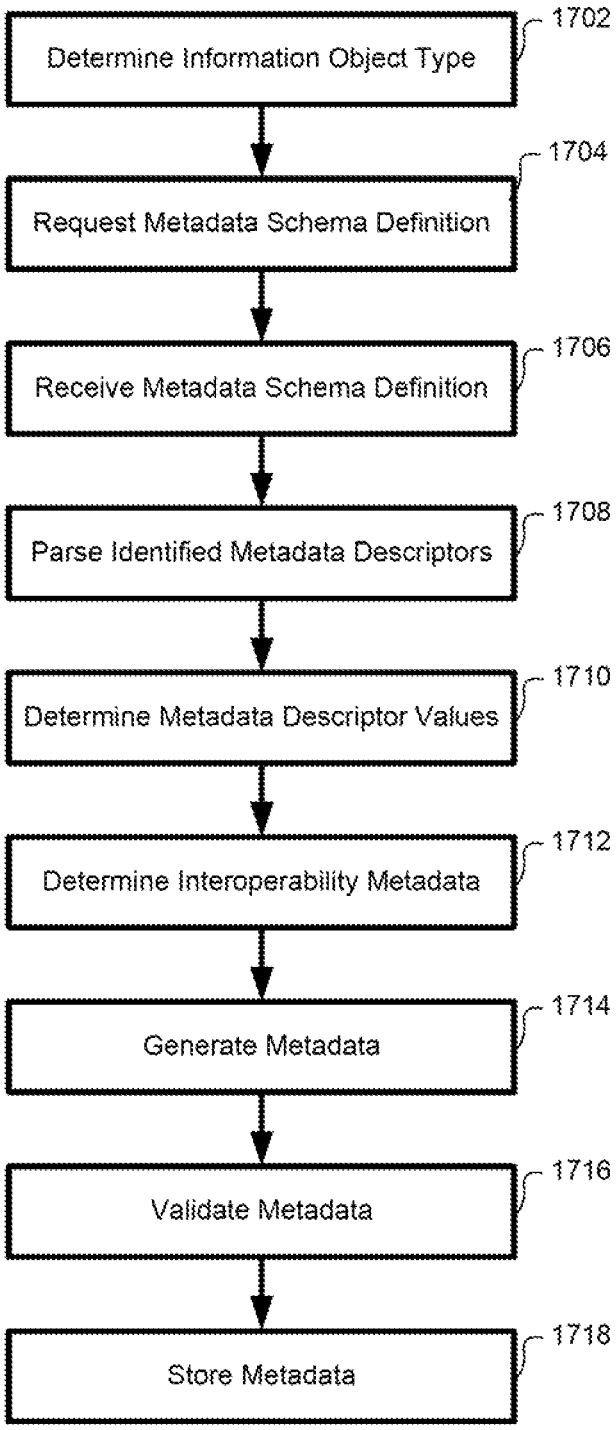
Determine Information Object Type
1702
Request Metadata Schema Definition
1704
Receive Metadata Schema Definition
1706
Parse Identified Metadata Descriptors
1708
Determine Metadata Descriptor Values
1710
Determine Interoperability Metadata
1712
Generate Metadata
1714
Validate Metadata
1716
Store Metadata
1718

*Figure 17*

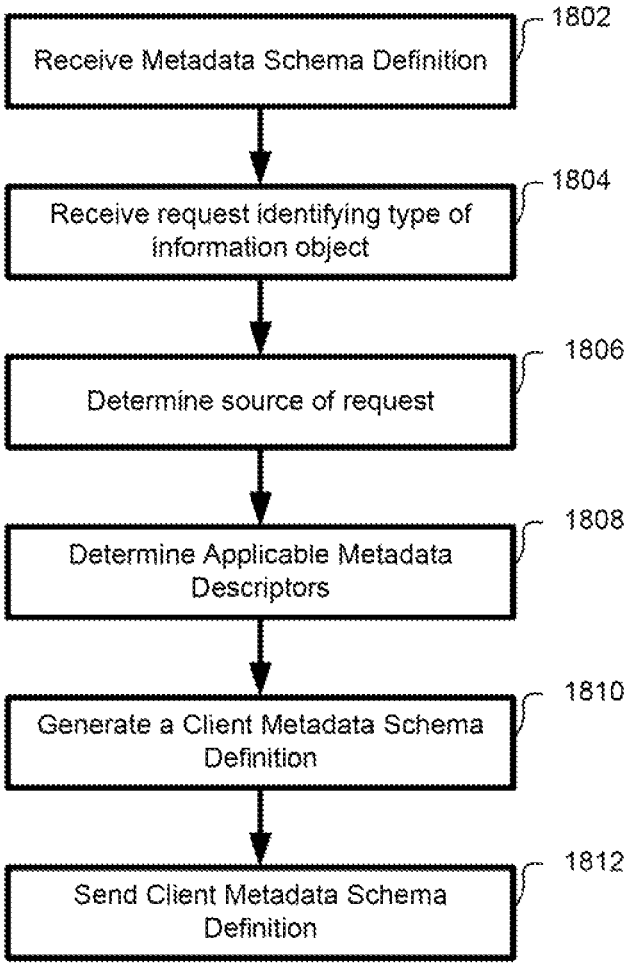
Receive Metadata Schema Definition
1802
Receive request identifying type of information object
1804
Determine source of request
1806
Determine Applicable Metadata Descriptors
1808
Generate a Client Metadata Schema Definition
1810
Send Client Metadata Schema Definition
1812

*Figure 18*

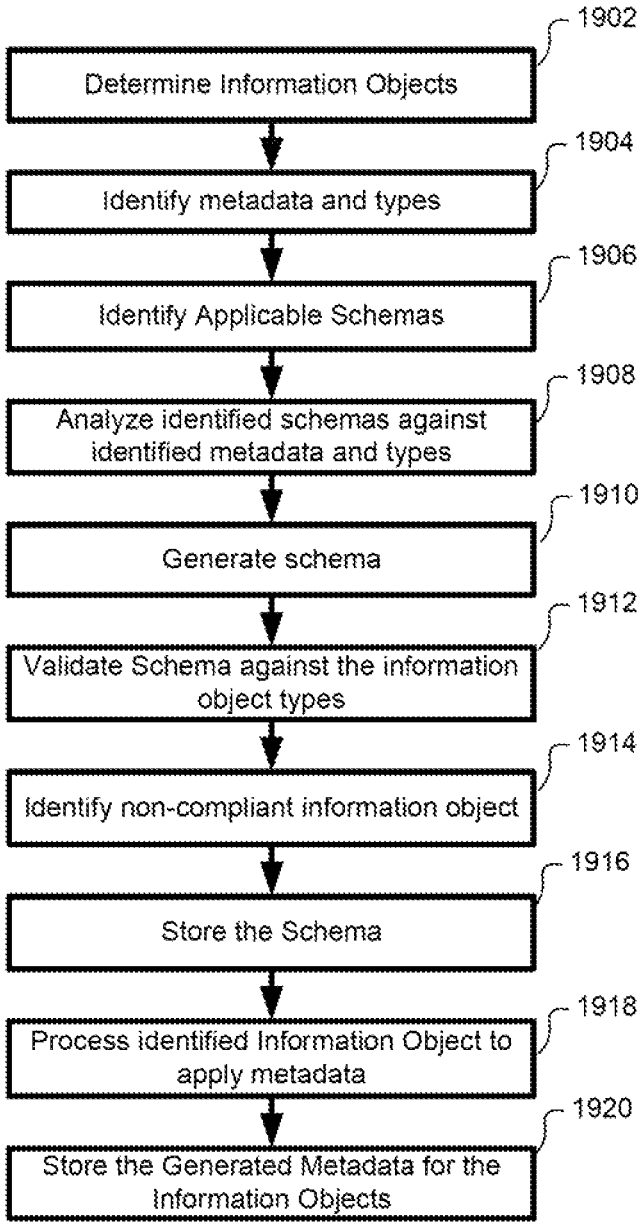
1902
Determine Information Objects
1904
Identify metadata and types
1906
Identify Applicable Schemas
1908
Analyze identified schemas against identified metadata and types
1910
Generate schema
1912
Validate Schema against the information object types
1914
Identify non-compliant information object
1916
Store the Schema
1918
Process identified Information Object to apply metadata
1920
Store the Generated Metadata for the Information Objects

*Figure 19*

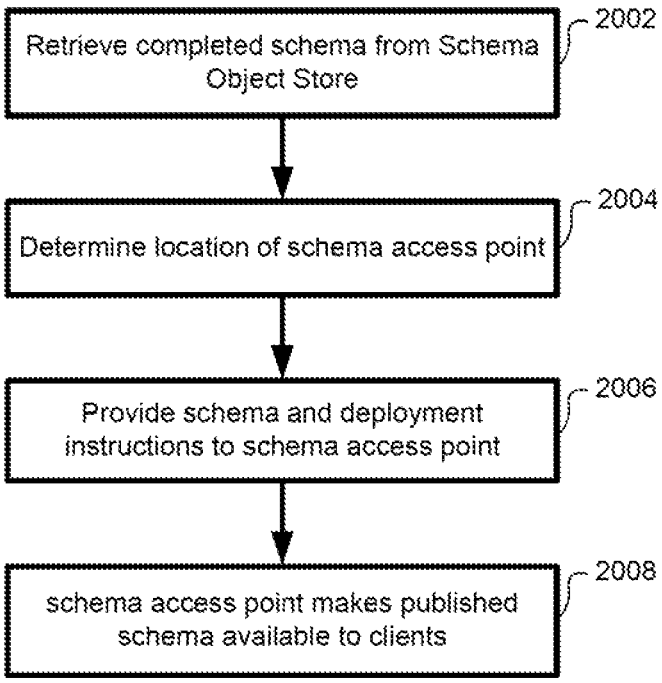
Retrieve completed schema from Schema Object Store
2002
Determine location of schema access point
2004
Provide schema and deployment instructions to schema access point
2006
schema access point makes published schema available to clients
2008

*Figure 20*

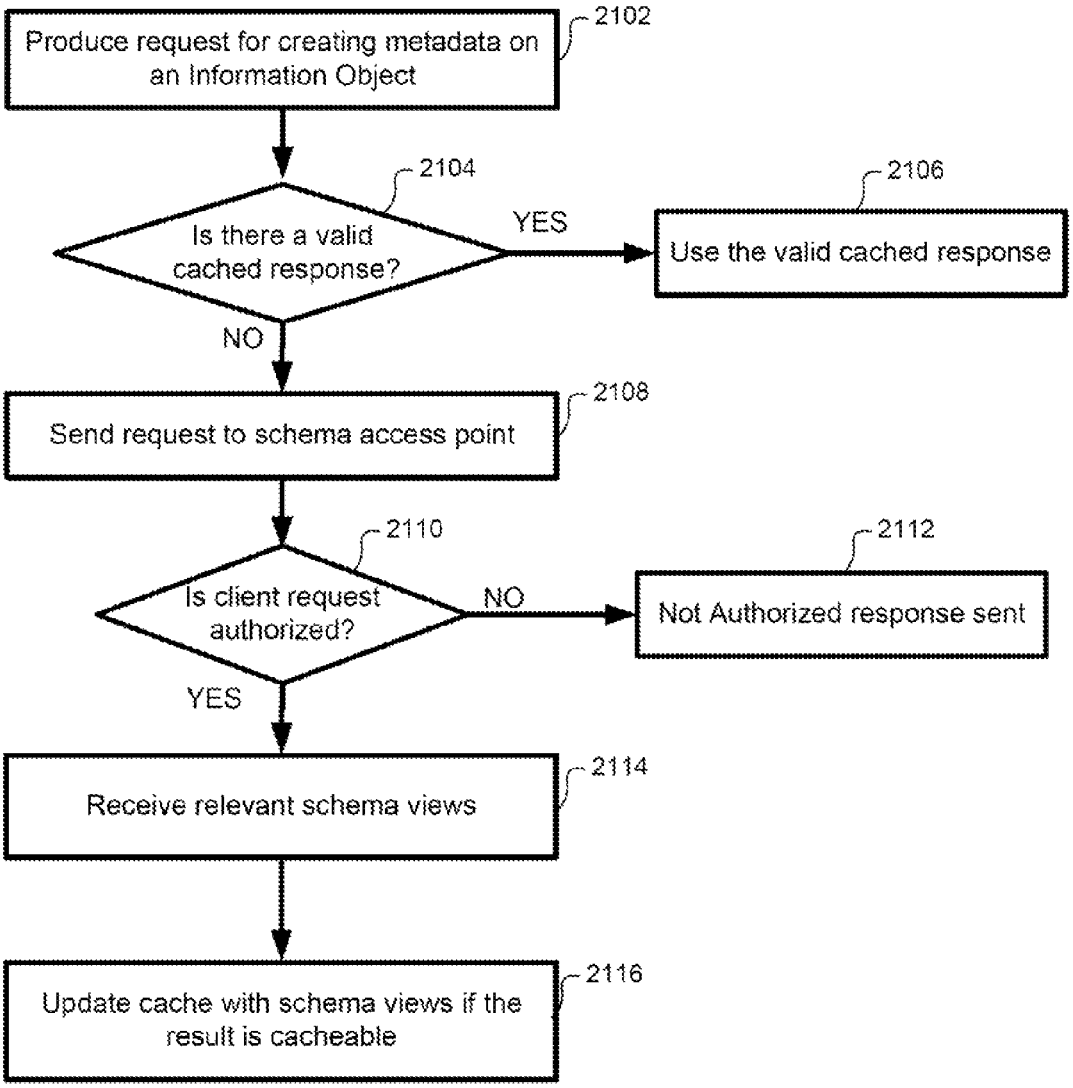
Produce request for creating metadata on an Information Object
2102
Is there a valid cached response?
2104
YES
Use the valid cached response
2106
NO
Send request to schema access point
2108
Is client request authorized?
2110
NO
Not Authorized response sent
2112
YES
Receive relevant schema views
2114
Update cache with schema views if the result is cacheable
2116

*Figure 21*

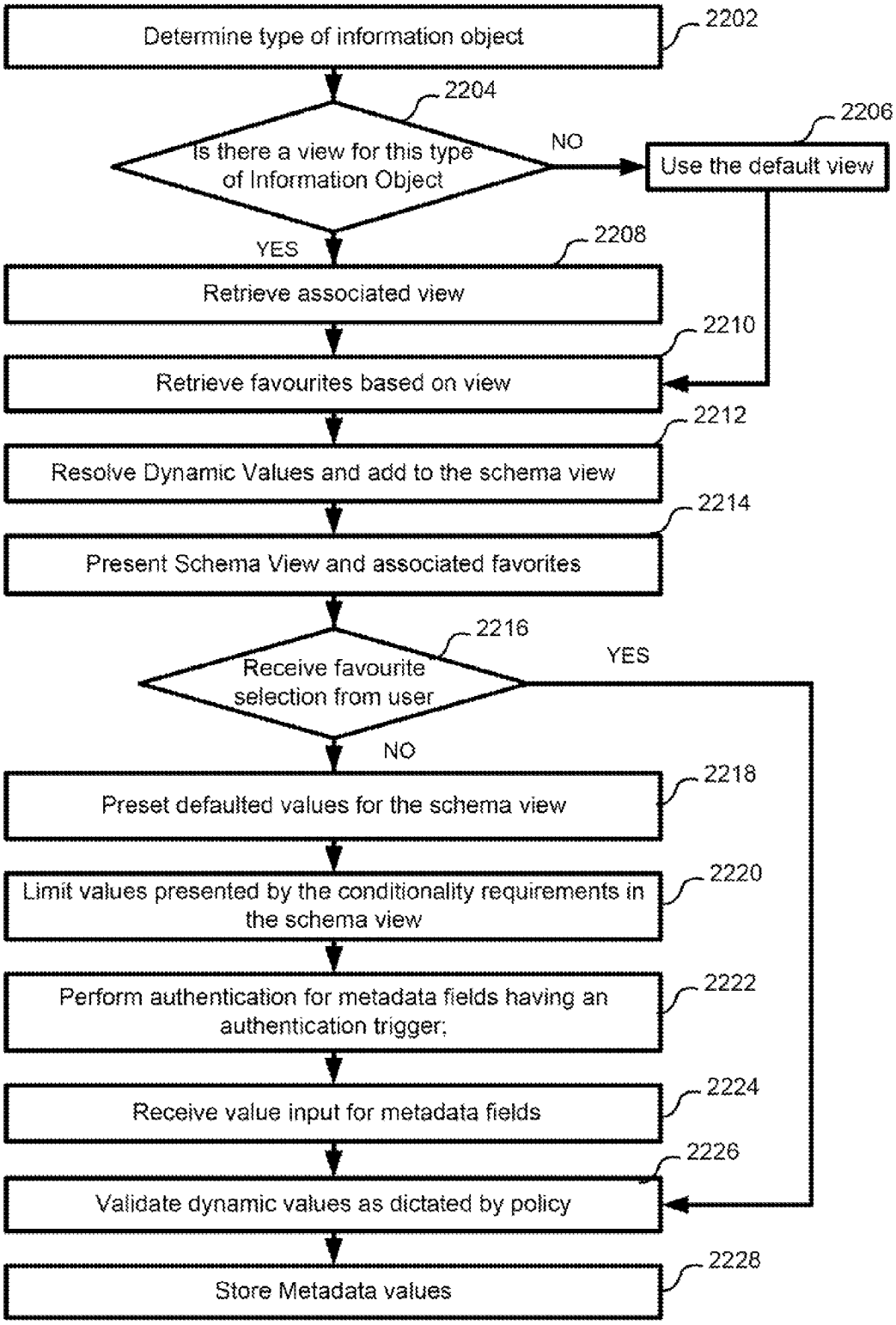
Determine type of information object
2202
2204
Is there a view for this type of Information Object
NO
2206
Use the default view
YES
2208
Retrieve associated view
2210
Retrieve favourites based on view
2212
Resolve Dynamic Values and add to the schema view
2214
Present Schema View and associated favorites
2216
Receive favourite selection from user
YES
NO
2218
Preset defaulted values for the schema view
2220
Limit values presented by the conditionality requirements in the schema view
2222
Perform authentication for metadata fields having an authentication trigger;
2224
Receive value input for metadata fields
2226
Validate dynamic values as dictated by policy
2228
Store Metadata values

*Figure 22*

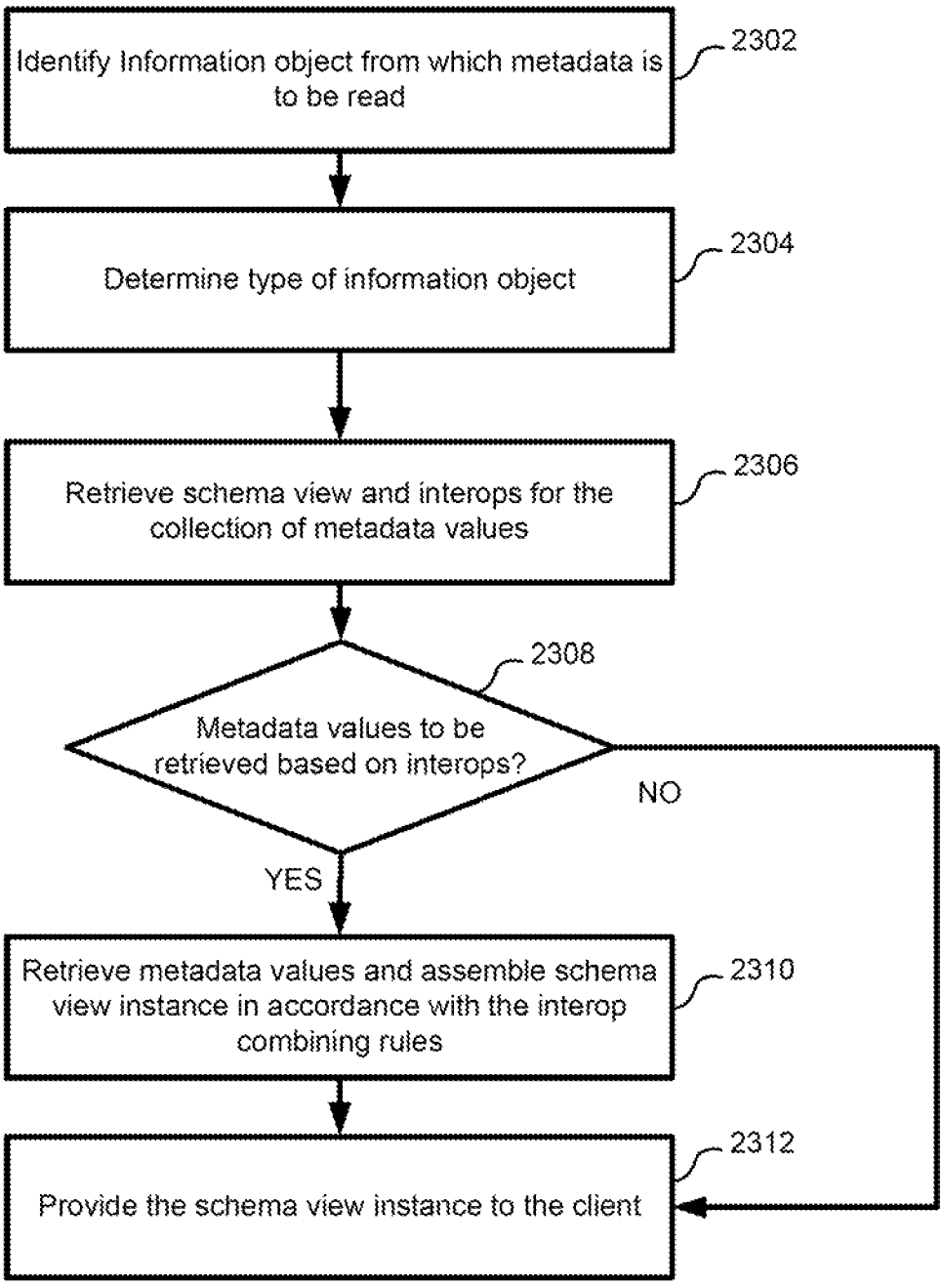
Identify Information object from which metadata is to be read
2302
Determine type of information object
2304
Retrieve schema view and interops for the collection of metadata values
2306
Metadata values to be retrieved based on interops?
2308
NO
YES
Retrieve metadata values and assemble schema view instance in accordance with the interop combining rules
2310
Provide the schema view instance to the client
2312

*Figure 23*

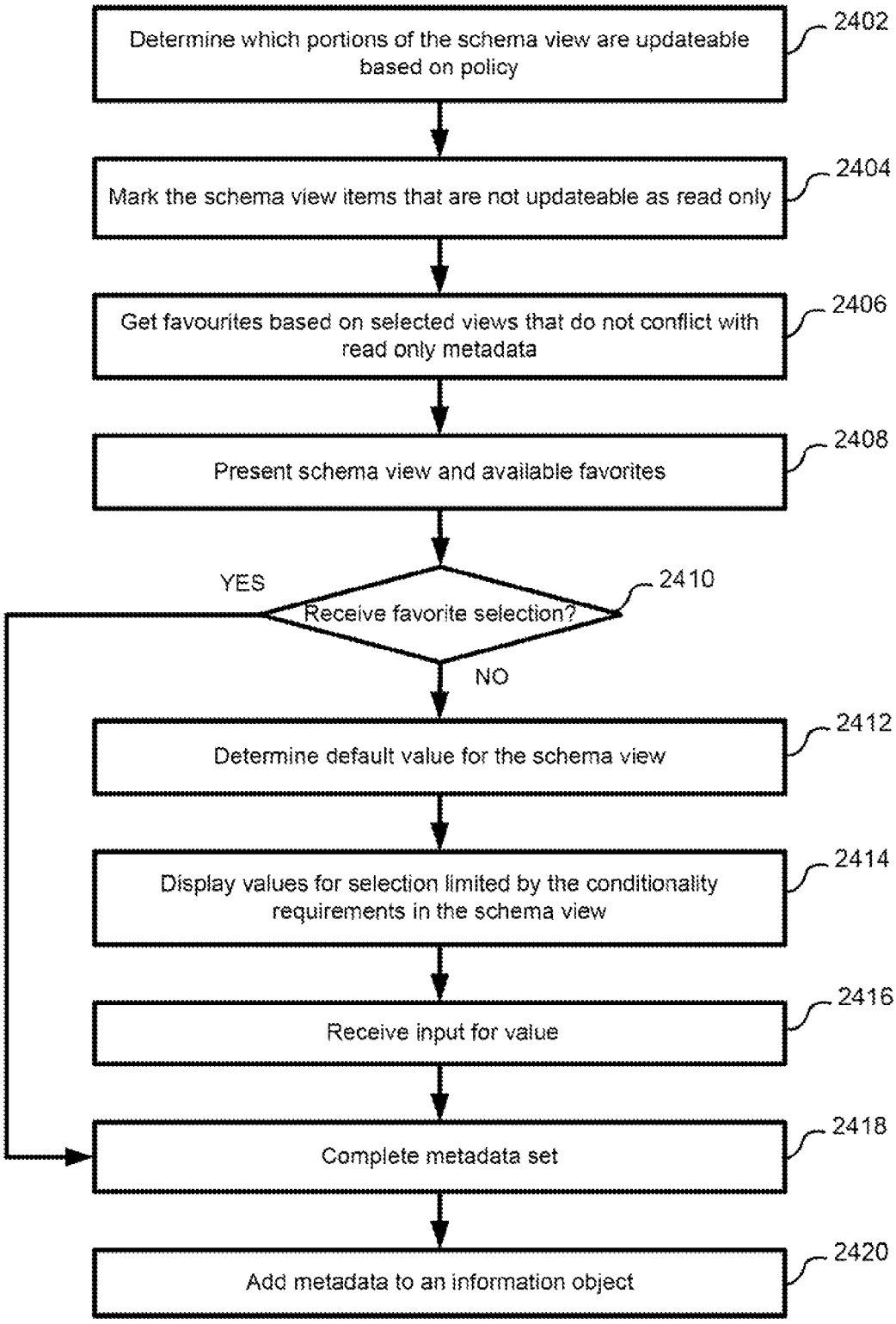
Determine which portions of the schema view are updateable based on policy
2402
Mark the schema view items that are not updateable as read only
2404
Get favourites based on selected views that do not conflict with read only metadata
2406
Present schema view and available favorites
2408
YES
Receive favorite selection?
2410
NO
Determine default value for the schema view
2412
Display values for selection limited by the conditionality requirements in the schema view
2414
Receive input for value
2416
Complete metadata set
2418
Add metadata to an information object
2420

*Figure 24*

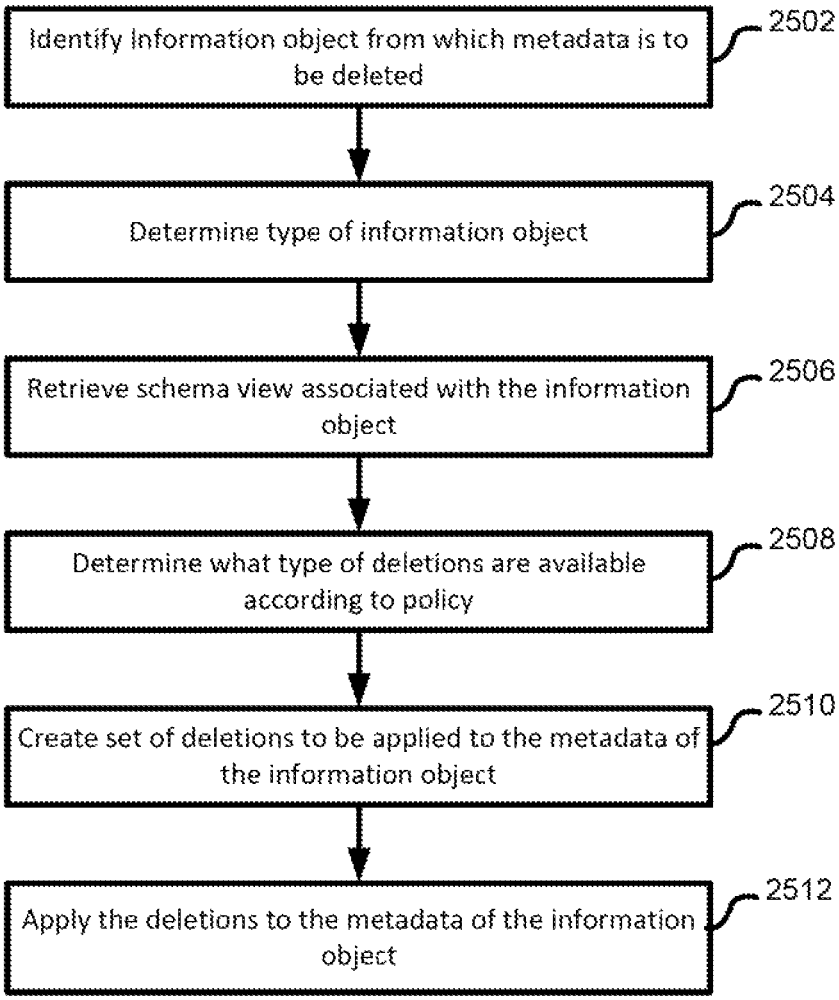
Identify information object from which metadata is to be deleted
2502
Determine type of information object
2504
Retrieve schema view associated with the information object
2506
Determine what type of deletions are available according to policy
2508
Create set of deletions to be applied to the metadata of the information object
2510
Apply the deletions to the metadata of the information object
2512

*Figure 25*

# METHOD AND SYSTEM OF HIERARCHICAL METADATA MANAGEMENT AND APPLICATION

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority from U.S. Provisional Patent Application No. 61/419,526 filed Dec. 3, 2010 and U.S. Provisional Patent Application No. 61/437,922 filed Jan. 31, 2011, each of which is hereby incorporated by reference herein in its entirety.

## TECHNICAL FIELD

The present disclosure relates to metadata associated with information objects and in particular to the creation and management of hierarchical metadata schemas to be applied to the information objects.

## BACKGROUND

The need for rich metadata is necessitated by the growth of data loss, Government regulation, application of new access control methodologies and the need to have policy based decisions on information management. The current state of the art solution using limited Name Value Pairs leads to organizations having to scan the content and in turn guess to a large extent the sensitivity of the document. As well, the document format itself may not be conducive to scanning since it may be in a non-parsable binary form or encrypted in some way.

The sharing of information across company departments, with partners and governmental bodies requires that the metadata associated with the information be consumable by the recipient in a form they are expecting. This includes:

- Native language of recipient
- Metadata schema expected by the recipient
- Data format of the metadata when received by recipient
- The applicability of portions of metadata schema may be influenced by values already associated with hierarchical assigned values, dynamically provided values and the context of the metadata values.
- The totality of a system wide metadata schema may not be applicable to every application of the schema.

Metadata itself is often described as data about data. The metadata schema is the fundamental representation of the relationships amongst the metadata items, the associated values, the context the metadata is applied to and the inherent operational characteristics intrinsically applied within the schema. The ability to manage, classify and organize this data is becoming increasingly complex with the exponential growth of data available.

Accordingly, methods and systems that enable hierarchical metadata management remain highly desirable.

## BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present disclosure will become apparent from the following detailed description, taken in combination with the appended drawings, in which:

FIG. **1** shows a system representation of hierarchical metadata management and application;

FIG. **2** shows a representation of a metadata infrastructure cycle;



FIG. **3** shows a representation of schema design and management;

FIG. **4** shows a schematic representation of schema access point;

FIG. **5** shows a schematic representation of client I/O manager API;

FIG. **6** shows a schematic representation of schema client API;

FIG. **7** shows a schematic representation of object I/O manager;

FIG. **8** shows a schematic representation of 3$^{rd}$ party APIs and user control;

FIG. **9** is a representation of a display of an application for generating a hierarchical metadata structure;

FIG. **10** is a representation of a display of an application for generating a hierarchical metadata structure;

FIG. **11** is a representation of a display of an application for generating a hierarchical metadata structure;

FIG. **12** is a representation of a display of an application for generating a hierarchical metadata structure;

FIG. **13** is a representation of a display of an application for generating a hierarchical metadata structure;

FIGS. **14** & **15** provide representation of a sample XML metadata schema;

FIG. **16** is a flowchart of a method of generating metadata for an information object type in an administrative function;

FIG. **17** is a flowchart of a method of generating metadata for an information object type;

FIG. **18** is a flowchart of a method of sending a metadata schema structure definition to a client;

FIG. **19** is a flowchart of a method of building a metadata schema autonomously;

FIG. **20** is a flowchart of a method of publishing a metadata schema;

FIG. **21** is a flowchart of a method of schema client interaction with a schema access point for retrieval of schema(s) and view(s);

FIG. **22** is a flowchart of a method of adding metadata to an information object;

FIG. **23** is a flowchart of a method of reading metadata from an information object;

FIG. **24** is a flowchart of a method of updating metadata for an information object; and

FIG. **25** is a flowchart of a method of deleting metadata from an information object.

It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

## DETAILED DESCRIPTION

Embodiments are described below, by way of example only, with reference to FIGS. **1-25**.

In accordance with an aspect of the present disclosure there is provided a method of metadata management which when executed by a processor comprising determining metadata descriptors and metadata constraints of one or more types of information objects stored in a memory; determining a metadata schema structure definition comprising a plurality of metadata descriptors and relationships between one or more of the plurality of metadata descriptors from the determined metadata descriptors and metadata constraints to be used to define metadata for the one or more types of information objects; determining an interoperability definition of one or more of the plurality of metadata descriptors, associated metadata values and a serialization definition to enable interchange with an external metadata schema format; generating a metadata schema including interoperability mappings in a

structured definition language using the metadata schema structure definition and the determined interoperability definition; and storing the metadata schema to the memory.

In accordance with another aspect of the present disclosure there is provided A computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management, the method comprising determining metadata descriptors and metadata constraints of one or more types of information objects stored in a memory; determining a metadata schema structure definition comprising a plurality of metadata descriptors and relationships between one or more of the plurality of metadata descriptors from the determined metadata descriptors and metadata constraints to be used to define metadata for the one or more types of information objects; determining an interoperability definition of one or more of the plurality of metadata descriptors, associated metadata values and a serialization definition to enable interchange with an external metadata schema format; generating a metadata schema including an interoperability mapping in a structured definition language using the defined metadata schema and the determined interoperability definition; and storing the metadata schema to the memory.

In accordance with yet another aspect of the present disclosure there is provided a method of metadata management stored in a computer readable memory, the method executed by a processor coupled to the memory, the method comprising: determining information object type of an information object; receiving metadata schema in response to a request based upon the information object type, the metadata schema comprising a plurality of metadata descriptors and associated constraints associated with the information object; parsing received plurality of metadata descriptors and metadata constraints defined in the metadata schema to determine valid metadata values for the information object type; determining metadata descriptor values to be associated with the received metadata descriptors from the information object; and storing the determined metadata descriptor values.

In accordance with yet another aspect of the present disclosure there is provided a computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management, the method comprising determining information object type of an information object; receiving metadata schema in response to a request based upon the information object type, the metadata schema comprising a plurality of metadata descriptors and associated constraints associated with the information object; parsing received plurality of metadata descriptors and metadata constraints defined in the metadata schema to determine valid metadata values for the information object type; determining metadata descriptor values to be associated with the received metadata descriptors from the information object; and storing the determined metadata descriptor values.

In accordance with yet another aspect of the present disclosure there is provided a method of metadata management at a schema access point executed by a processor, the method comprising: receiving a request from a client computing device identifying an information object type; determining an identity associated with the client computing device and associated security and configuration parameters; determining applicable metadata schema in a structured definition language for information object type from a plurality of metadata schema based on the security and configuration parameters; generating a client metadata schema using the applicable metadata schema and the determined security and configuration parameters; and sending the client metadata schema to the client computing device for application of the client metadata schema to information objects of the object type.

In accordance with yet another aspect of the present disclosure there is provided a computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management at a schema access point, the method comprising: receiving a request from a client computing device identifying an information object type; determining an identity associated with the client computing device and associated security and configuration parameters; determining applicable metadata schema in a structured definition language for information object type from a plurality of metadata schema based on the security and configuration parameters; generating a client metadata schema using the applicable metadata schema and the determined security and configuration parameters; and sending the client metadata schema to the client computing device for application of the client metadata schema to information objects of the object type.

Some aspect of the present disclosure are to provide a methodology and system to build a rich metadata schema that can represent the entire business process of an entity to meet internal and external needs. The metadata schema will also reflect the attributes of the information objects. Intelligence in the design and application of the metadata schema is provided to facilitate information security, access control and interoperability of any information resource or information type. The metadata schema structure definition enables dynamic interchange of metadata labels and values between native languages, schemas and information formats and provides a new metadata paradigm to describe the metadata relationships between individual metadata entries and the information it is describing. The end consumer of the metadata can then have an intelligent and bounded way to supply values for the needed metadata elements. The ability to display intelligent views of the complete metadata schema to end consumers that are applicable to their role or the information they are labelling is facilitated by the dynamic metadata schema structure definition. In addition by defining a structure for application of metadata to information objects, malicious or inadvertent data loss can be stopped. The association of this metadata allows for the information to be controlled, monitored and stored in such a way to prevent the data loss from happening. The present disclosure addresses these issues by providing an intelligent metadata system for the association of metadata to information objects, ranging for electronic documents to physical objects having an electronic representation in a computing environment. By doing this, governmental regulation, internal audit and proprietary information can be controlled and kept confidential.

In addition with organizations applying their own metadata schemas to information objects, the metadata schema structure definition discloses enabling information to be securely shared inside and across a company or between companies and suppliers by ensuring that meaningful metadata associated with the information objects are provided and consumable by the end systems. The association of interoperable metadata needs to reflect the native language of the recipient, the metadata schema being used by the recipient and the format of the metadata being used. Recipient language mapping is solved through the mapping of a generic identifier for the metadata item and value. These generic values are then associated with a matching language string for both the metadata label and value. In this way, the native language of the recipient dictates the metadata label that is displayed and the

associated value. This provides the ability to author the schema and metadata in one language (the default language) and then provide additional language values. This translation is done seamlessly and does not require end user involvement.

When exchanging information with associated metadata the recipient organization may represent the metadata attached to the information object in a different format. Metadata format differences have in the past prevented the secure sharing of information and have caused data loss. Interoperability is provided between creator and receipt of the information. This interoperability dynamically maps one schema of metadata to another. The use of interop ID allows the metadata schema structure definition to seamlessly and automatically translate the creator's schema to the recipient's schema. While the metadata schemas between recipient and sender can be dynamically mapped, it may be required to provide the metadata associated with an information object in a particular format. The metadata associated with the information object may need to be provided in a proprietary format, or transformed into a different layout or order. To accomplish this, a dynamic mapping capability can be associated to an interop ID. This way as the metadata schema and values are dynamically transformed for the recipient, the format of the metadata can also be provided in the recipient's native format.

The application of metadata to an information object is a critical part in preventing data loss. The metadata is associated in a way to provide the most accurate representation of the information object. In doing this a user may need to provide additional metadata values based on ones that are previously set. The current metadata systems in use, present the user with a complete list of all possible metadata labels and values, in this way, the user is expected to fully understand the scope, meaning and interrelation of these labels and values. This can lead to inadvertently applying metadata insufficiently to prevent data loss or the contrary, causing the information to have metadata that too strongly restricts its use. To address this the disclosed metadata schema structure definition allows for the application of conditional statements on metadata labels and associated values. These conditional statements would cause additional metadata labels or values to be set, or selectable or not by the user. These conditions allow all of the arithmetic operators and conditional logic to be used in the application of metadata to an information object. With the addition of these labels an end user applying metadata to the information object would be guided in the application of the metadata.

For a company to sufficiently apply metadata to all of the information objects it creates requires the modeling of a very complex metadata schema. The complete metadata schema may not be applicable to every information object or information object type. The applicability to a particular set of metadata schema to prevent the application of all metadata to an information object, this disclosure allows for the creation of schema views that can be assigned to an information object type, these views allow for portions of the overall schema to be applied.

FIG. **1** provides a high level overview of the creation, distribution and consumption of a metadata schema. A user or process, referred to as schema administrator **100**, executing on a computer device having for example a memory **101** and a processor **102** in addition to network functionality, describes the collective metadata in terms of descriptors and any constraints associated with the chosen descriptors **108** in a schema structure definition **104**. The schema administrator **100** is coupled to one or more computer networks **112** and **122** to deliver schema structure definitions **104** to a schema client **140** that may be executed on a computing device having at least a memory **141** and processor **142** and may be coupled either locally or remotely to a storage device **143** having information objects **146**. The computing device may also provide a display and input capability to enable user input in terms of using and manipulating the metadata schema and values of information objects. A schema access point **120** may be provided coupled to one or more of the networks, in this example it is shown between the schema administrator and client, however its relative location is not a limitation. The schema access point **120** may be a network server or computing device having at least a memory **121** and processor **122** and coupled to a storage device **123** either locally or remotely providing metadata schema structure definitions **104** and schemas **114** for executing schema management functions. Although the schema administrator **100**, schema access point **120** and schema client **140** are depicted as separate entities the execution of their respective functions may be performed on the same device or distributed between many devices as required.

Metadata descriptors **108** may be related to content or information used to define the information objects **146** or may be related to organizational requirements or functions. The information objects **146** may be any form of electronic data file, or any type of electronic data container containing content or reference external content or devices that may require metadata to be associated with it. The information objects **146** may be stored in one location such as a storage device **143** or may be stored or referenced in many locations in a network based storage environment. The administrator **100** may assign policy restrictions **110** on the schema structure definition **104** in terms of metadata descriptors **108** that can be created and the attributes of those information objects **146**, what areas of the schema can be updated, and their ability to publish defined schemas.

The metadata descriptors **108** can have multiple relationships defined as interoperability maps **106** between each other external entities **126** and possible external schema value providers such as computing device or embedded devices **128**, mobile devices **130**, data providers such as global positioning system **132** or any data source or collection device that may be queried to provide data for input to the metadata values. The defined schema **104** may reference to, or interact with disperative schemas from external entities **126**, processes or with schemas that contain different metadata descriptors. These interoperability definitions **106** can also include a serialization definition for the interchange of metadata enabling interoperable schemas. The interoperability is important when information objects are accessible between consumption domains such as between corporate organization or departments. The schemas **114** are generated using a metadata schema structure definition **104** applying a structured definition language that will enable the definition of the metadata schema structure, constraints and any interoperability. The generated metadata schema **114** including all descriptors, constraints and interoperability is stored in a storage device **103**. The generated metadata schema **114** contains validation definitions that enable schema validation against stated or implied metadata constraints for the descriptors or the values of the defined metadata descriptors.

When a client or process requires a schema it is **120** retrieved from the **123** published store. The schema **114** may be defined to enable bi-direction exchange of metadata and format of the information object **146** stored in storage device **143** between schema **114** and a schema required by an external entity **126**. In defining the schema, there are instances when having a user prove identity through authentication can

further enhance the security, non-repudiation, or access to metadata values or to dynamic value providers **124**.

The schema structure definition **104** can be defined as a model for the entire metadata definition to generate a schema **114** for an entity such as a corporate organization. As such, views **104** which are parts or subsets of the defined schemas **114** may be made available for consumption based on factors such as information object type, user, role, security level, application, process or other similar needs. The schema **104** can include conditional evaluation of one or more metadata descriptors or their value(s) in deciding to display, evaluate or set metadata descriptors and their associated values. The values predefined in the schema **114** for metadata descriptors do not necessarily have to be static. Values can be provided dynamically from sources that are referenced as providers of values. These dynamic value providers **124**, **128**, **130**, **132** can be of any data type and may also include the dynamic linking of other compatible definitions of metadata descriptors and associated schemas. In turn, static definitions of values for metadata descriptors **108** can as well be specified in the schema structure definition **104**.

The complexity of metadata implementations may involve the creation of more than one instance of a metadata descriptors **108**. These additional instances of the metadata descriptor will provide cardinality to the schema structure definition and allow from 0 to n instances of that metadata descriptors **108**. Once the schema structure definition **104** is created it is published through the schema access point (ScAP) **120** which receives a metadata schema structure definition **123** and associated interoperability mapping. The received schema structure definition is stored in a storage device **123** and may also store schemas **114** generated from the schema structure definition **104**. The schema access point **120** will receive a request identifying a type of information object from a client **140** and based on policy **110** and possible authentication of the user, process the applicable metadata descriptors and associated interoperability mapping from the metadata schema based upon the source and type of information object to generate a schema or a schema view to pertain to the information object **146**. The schema or view may also define ranges and constraints for information to be stored in the metadata to be associated with the information object **143**. Once metadata has been applied to the information objects **143**, the metadata can be used for; categorizing, searching, securing, control, access, presentation and modification through various functions in regards to consumption, application and use of the information objects **146** by schema clients **142** or other consumption devices.

FIG. **2** shows a representation of a metadata infrastructure cycle diagram from creation to consumption. The process begins with schema design and management function **214** provided by the schema administration **100** that are used to design the schema and to eventually publish the schema to schema access point **120** schema access point function **212**. The final output of this is a schema structure definition file that describes the metadata infrastructure for the application of metadata to all information objects. When the schema is finalized, schema access point function **212** receives a request to publish the schema for consumption by end users, automated systems, information brokers and other systems that require rich metadata with the information objects on which they operate. The schema access point **212** receives commands from in regards to which schema(s) to publish to the appropriate configured repositories. Schema access point function **212** also responds to requests from client I/O (Input/Output) manager **210** on behalf of schema client API **206**. Client I/O manager API (Application programming interface) **206** receives client requests through schema client for schemas, schema views and dynamic value providers, as well, client I/O manager API **210** provides caching services of schemas, views and dynamic value providers to schema client **206**. Client I/O manager API **210** provides schema serialization configuration. Schema client **206** requests schemas and views from client I/O manager API **210**. With these schemas and views object I/O manager **210** is called to read and write metadata to and from information objects **146**. If the information objects are being updated with metadata values that are replacing or supplementing existing values, then schema client **206** correlates the existing metadata with any new values. As well, schema client **206** is responsible for serializing metadata coming to and from the client I/O manager **208** and applications **202**. Schema client **206** also provides the serialized metadata object to the applications **202**. Schema client **206** also provides for collection of metadata and the presentation of metadata to and from Information object in either a 3rd party callable API or through a standard user control **204**. Object I/O manager **208** provides reading and writing of metadata to and from information object in a repository associated with the information object. Applications and 3rd parties **202** represents the final part of the metadata infrastructure cycle by providing consumption methods of 3rd party APIs or user control **204** instantiated as user interface on the computing device for collection or displaying of the metadata

FIG. **3** shows a representation of schema design and management diagram: Schema design and management **214** provide a graphical user interface, for example as shown in FIGS. **9-13**, and expose the schema builder API **304** for 3rd party consumption. Schema design and management **214** in consuming schema builder API **310** implements Creation, Read, Update and Delete functionality (CRUD) on the schema being developed. Schema builder API **310** utilizes schema object store **302** for the storage of the schemas in an xml format, for example as shown in FIGS. **14** and **15**. Schema publisher **304** and deployment API is used by schema design and management **304** for the publishing of schema structure definitions and deployment instructions from schema object store **302** through schema access point **212**.

FIG. **4** shows a schematic representation of schema access point **120** function diagram. Schema access point **212** receives requests for schemas, view(s) and dynamic value providers from schema design and management **214**. The request can be accompanied with a set of credentials to authenticate the identity of the requestor. The credentials could be a unique identifier and passcode, a set of claims, roles or other significantly strong and unique identifications. Based on a successful authentication by a schema access manager **404** retrieves the requested schemas and views from **402** schema data store. As well, any dynamic value provider definitions in the schemas or views is requested through dynamic value provider **412**. The schemas and views returned through schema access point **212** are sent to security services **408** where based on policy services **406** they may be cryptographically encrypted and signed to ensure secure delivery to the requesting schema design and management **214** or applications or 3rd party APIs **202** or User Control **204**. Security services **408** provide encryption, signing and authentication services to all parts of the metadata infrastructure. Policy services **406** provides policy decisions and authorization requests to all parts of the metadata infrastructure. Policy services **408** can provide self-contained policy decisions or can reach out to 3rd party policy services reachable through Security Assertion Markup Language (SAML) or other like

protocols. Dynamic value providers **412** return dynamic values for metadata descriptors that are configured to use dynamic values. The source of dynamic values can be information systems, external data source, physical devices or anything else that exposes an interface. Schema data store **402** is the authoritative source of all schemas and views. The store **402** itself can take any form that supports the storage of information in either a relational way or non-relational way and can be local to the client machine, in the enterprise or stored in a distributed or cloud environment. Client I/O manager **210** requests schemas, views, dynamic values, policy services **210** and security services **210** from schema access point **210**. Schema access point **210** can be located on the client, in the enterprise or in the cloud.

FIG. **5** shows a schematic representation of client I/O manager API diagram. Client I/O manager API **210** services requests from Schema clients **210**. When a request for a schemas, views or dynamic values is made, client I/O manager **210** references off-Line schema cache **510**. The configuration for the freshness of the cache and which requests are eligible for retrieval from cache is provided from client schema manager configuration **506** through schema client manager **504**. If the requested information is not in the cache, or the cache is expired then a request is made to schema access point **212**. When the request is returned from schema access point **212**, it is cached or portions are cached based on the policy services **406** as referenced by schema access point **212** when servicing the request. Schema access point locator **514** provides the location of the schema access point **212** to client I/O manager API **210**. The location of schema access point **212** is dependent on the deployment of schema access point **212**. Schema client manager **504** provides configuration services to both schema access point locator **514** and client I/O manager **210**. The location of client schema manager configuration **506** can be local, on an enterprise server or stored in network accessible storage. Off-Line cache **510** is stored locally to the requesting client. The cache **510** can be signed and encrypted for the specific client that has requested the cache.

FIG. **6** shows a schematic representation of schema client API. Schema client services **206** requests from 3rd party APIs **202** or User Control **204** for reading and writing of metadata from information objects. To facilitate that request schema selector **606** generates schema view object **608** based on the current schema or view for information object and is passed to schema client **206** for formatting or editing metadata. Schema client **206** correlates metadata read from information object with the matching schema view object **608**. Schema serialization **604** provides serialization services for converting the metadata format stored with Information object to the native format. Serialized metadata object **610** is the result of serializing the metadata format from information object and is passed to schema client **206** for use correlating the metadata.

FIG. **7** shows a schematic representation of object I/O manager. Object I/O manager **208** receives a request to read or write metadata associated with information object **708**. Object I/O manager **208** determines the type of information object **708** and passes it to schema clients **206** for selection of schema view object **608**. Based on the schema view object **608**, a serialized metadata object **610** is created. Based on the schema view object **608**, metadata I/O plugin manager **704** knows which metadata plug-in **706** to use to read or write the metadata to or from information object **708**. The metadata is either added to the information object **708** from the serialized metadata object **610** or the read metadata is added to the serialized metadata object **610** and passed to schema client **206** for serialization and correlation.

FIG. **8** shows a schematic representation of applications and 3rd party APIs **202** and user control **204**. An instantiated user interface **802** on the schema client is from user control **204**. When metadata is to be added to information object **708**, a request is made to schema client **206** to determine the view for the information object **708**. A schema view object **608** is returned and used to initialize 3rd party APIs **202** or user control **204**. When metadata is collected for information object **708**, it is placed in a serialized metadata object **610** and passed to schema client **206** for association with **708** information object. When metadata is read from **708** Information object, it is returned to 3rd party APIs **202** or user control **204** in a serialized metadata object **610** and a schema view object **608** to initialize 3rd party APIs **202** or user control **204**.

FIG. **9** is a representation of a display for a schema configuration for generating a hierarchical metadata structure. The hierarchical metadata **902** is shown for a sample schema. The tree structure display **902** show clearly the relationship amongst metadata descriptors. As well views of the metadata schema is shown, including a default view that contains all of the metadata descriptors and a view called "Test" that includes a reduced set of metadata descriptors. General settings **906** provides for the example schema including its name, the namespace URI and the Namespace Prefix used in the sample schema. The sample schema has an additional language **908** for example a definition of Spanish. Supported names for the language definition are selectable from ISO 3166-1 Alpha-2 code. The definition of an interoperability provider called "Tituscorp" is provided in **902** which is used to be able to specify a mapping between the sample schema and a schema supported through the "Tituscorp" interoperability provider. The user of the schema administrator can edit information provided to modify the schema structure definition information.

FIG. **10** is a representation of a display of the Root Level of a Schema for generating a hierarchical metadata structure. An ordered list **1002** is provided of all metadata descriptors defined in the example schema, they are listed in the order in which they appear in the hierarchical schema in the left side pane **902**. Root fields **1004** are shown only for the example schema. The example schema only has one root entry called "Security" and its metadata descriptor type is group. Any metadata descriptor type can be a root field. There can be multiple root fields, allowing for multi-root branching of the schema.

FIG. **11** is a representation of a display of metadata descriptor attributes for generating a hierarchical metadata structure. Shows some attributes of the metadata descriptor "Classification" **1102**. The fully distinguished name (FDN) for metadata descriptor "Classification" is shown beside the label "Field Properties". The FDN for the metadata descriptor is "Security.Classification". This represents that "Classification" is a direct child of the parent metadata descriptor "Security". As well the metadata descriptor field type "List" is shown. The supported metadata descriptor field types include; string; Number; DateTime; Boolean; List and Group. Since an alternate language was defined, the alternate language display **1104** shows the alternate Text and Tooltip for the metadata descriptor. If multiple languages had been defined, then multiple sets of Text and Tooltip would be used for each language enumerated in **908**. **1106** shows that a metadata descriptor "BusinessRisk" is a child of the current metadata descriptor "Classification".

FIG. **12** is a representation of a display of metadata descriptor attributes for defining conditionality and dynamic value provider for generating a hierarchical metadata structure.

That the conditionality **1202** of metadata descriptor "Security.Classification.BusinessRisk" has its visibility conditionally on its parent metadata descriptor "Security.Classification". "Security.Classification.BusinessRisk" will only be shown if the parent metadata descriptor has a value of one of the following: Secret; Confidential or General Business. The values **1204** metadata descriptor "Security.Classification-.BusinessRisk" is a dynamic value provider receiving its values from a Directory Service for example Active Directory™ attribute called BusinessRISK. A dynamic value provider can be any accessible data source in which the retrieved data may change over time. A dynamic value provider may provide a value to be stored in the metadata of the information object or maybe identified by a reference in the metadata of the information object. By using a reference to the dynamic value provider with in the metadata of the information object, when the metadata is retrieved an associated value is also retrieved from the associated dynamic value provider enabling real time values to be populated in the metadata. This can facilitate a trigger to change properties of the information object or related dependencies. Conditionality may also be applied in regards to the dynamic value provider in terms of a resulting value returned by the dynamic value provider and courses of action that may be performed in response to the returned value. As well the attribute on the dynamic value provider to show unmapped values is set to yes. In this setting, any values that do not have a definition in the mapped values table will still be returned. Mapped values table allows for the mapping of a dynamic value to a valueID that in turn can have a text label that is more user friendly in its naming convention. A dynamic value provider List can also contain static values to supplement the mapped values. These additional values are added to the possible list values by an explicit definition in the mapped values table.

FIG. **13** is a representation of a display of attributes of a metadata descriptor value for generating a hierarchical metadata structure. A value of a metadata descriptor of type list can have an alternate language **1302** associated to it as defined in the language settings **908**. If multiple languages had been defined in **908**, then multiple sets of text and tooltip would be used for each language enumerated in language settings **908**. As well conditionality can also be set on the list value. In this case the value of "High" will only be provided as a selection choice if the parent metadata descriptor "Security.Classification" has a value of: "Secret" or "Confidential".

FIGS. **14**, **14***a*, **15**, **15***a* and **15***b* concatenated together form the complete sample schema. FIG. **14** is a Schema fragment **1402** show the schema structure definition including version of the Schema format, character encoding, schema name space and the name space prefix. **1401** outlines the additional Languages defined for the Schema. **1406** lists the interoperability providers. **1408** show the use of additional language definition for a metadata descriptor. **1412** shows how metadata descriptors are designated to be part of a view. FIG. **15** is a Schema fragment **1502** show the schema structure definition for a dynamic value provider. **1504** shows schema conditionality for a metadata descriptor based on the parent metadata descriptor values of "Secret" or "Confidential". FIG. **15***a* is a schema fragment **1502***a* shows schema conditionality on a metadata descriptor value based on the parent metadata descriptor value of "General Business".

FIG. **16** is a flowchart of a method of generating a metadata schema in an administration function. The metadata constraints are determined (**1602**) based on the type and nature of the information objects to have metadata associated with them. This can include the importance, impact and risk of that information object being improperly handled, exposed or used for unintended purposes. These metadata constraints will help in determining the types of metadata descriptors to be used in the creation of schema as well as possible valid value ranges to be associated with the metadata descriptors. Certain metadata descriptor values may not be downgraded to a lower value or changed at all. As well the supported languages for the schema. The metadata schema structure definition is determined (**1604**) in a hierarchical manner. The hierarchical structure will again be driven by the discoveries based upon the determined metadata descriptors and constraints and discernable interrelationships between descriptors and constraints. In addition, the metadata structure definition may account for multiple information object types in determining the appropriate metadata structure. Some of the structure decisions will include: the branches of single or multiple root metadata descriptors; if some of the branches because of sensitivity or "Need to know" may be restricted with a secondary authentication mechanism. The interoperability definitions are determined (**1606**) and requires comparing the created schema to already existing schema for interoperability possibilities for both the metadata descriptor and value, as well as any specialized serialization of the metadata from the current metadata schema to an existing one. Mapping constraints are generated (**1608**) based upon interoperability definitions entails generating schema rules to describe the mapping of native metadata descriptors and associated values to their equivalents in the interoperable schema. The metadata schema is generated (**1610**) and involves: the adding of additional metadata descriptors on the defined branches and roots; setting of metadata descriptor attributes; value ranges on the metadata descriptor attributes; conditionality of metadata descriptors and values to enable the "guiding" of the metadata selection; the specification of alternate languages as defined; and the determination of which metadata descriptors should referenced in different views based on the information object type to be associated to that view. The metadata schema is validated (**1612**) against determined constraints, a consistency check on the metadata descriptors and values such that they fit inside the constraints. The proper access rights are available for the dynamic value providers defined and the proper On Downgrade or On Change attributes are set on the appropriate metadata descriptors. The metadata schema is stored (**1614**) in a safe non deployed area before it is published. The stored schema can be encrypted and signed to guarantee confidentiality and trust. As well, when the schema is to be published, certain parts of it may require signing and or encryption based on the importance or secrecy of the metadata descriptors and their associated values.

FIG. **17** is a flowchart of a method of generating metadata for an information object type. An information object type is determined (**1702**) by examining the unique data points that differentiate this information objects from others. A metadata schema structure definition is requested (**1704**) to a access point or by a query to a schema database based on the determined information object type. The object type may be defined based upon one or more properties associated with the information object and/or or based upon the location or access method to the information object type. That is an information object type may have different schema associated with it depending properties associated with but not necessarily contained in the information object, such as storage location. A metadata schema structure definition is received (**1706**) from the access point or schema database in response to the request and is used for the information object, this includes verifying the signature on the schema, and decrypting parts of the schema encrypted for confidentiality.

Identified metadata descriptors are then parsed (**1708**) to determine the metadata descriptors and associated values to be displayed on the schema layout that needs to be pragmatically provided by a 3rd party application through schema client **206**. Metadata descriptor values are then determined (**1710**) based on the values provided by the user or 3rd party application in conjunction with any values provided from dynamic value providers or if there was existing metadata with the information object. Once the metadata is determined, any interoperability metadata is created (**1712**) based on the interoperability mappings and mapping rules included with the schema. The metadata is added (**1714**) to the serialized metadata object **610** and any interoperability providers. A consistency check can then be performed to validate the metadata (**1716**) added or updated against known constraints for the metadata schema and any interoperability providers. The metadata is then stored (**1718**) by passing the serialized metadata object **610** to schema client **206**.

FIG. **18** is a flowchart of a method of sending a metadata schema structure definition to a client. A metadata schema structure definition is received (**1802**) when **210** client I/O manager has a cached schema or can contact schema access point to get schema(s) and view(s). A request to identifying type of information objects is received (**1804**) through from a computing device which needs to classify an information object to a schema view object **608**. The source of request is determined (**1806**) so the proper schema(s) and view(s) are returned based on policy services **406**. A client metadata schema structure definition is generated (**1808**) based on schema view object **608** and the results of policy services **406**. The generation of metadata schema structure definition may also include interoperability definitions from the metadata schema structure definition and a serialization definition to enable interchange with an external metadata schema format based upon the source of the request. Once the appropriate metadata schema structure definition has been generated the client metadata schema structure definition is sent (**1812**) to the schema client **206**.

FIG. **19** is a flowchart of a method of building a metadata schema autonomously. An automated system for examining a corpus of information objects to determine the type of metadata that can be associated with the objects. The system analyzes the information objects stored in one or more storage device to determine (**1902**) information that can be associated with the object. This maybe performed based on metadata existing with the object, discernible characteristics of the object such as content of the object, information object attributes, using templates to determine the types of metadata available or by performing an analysis of the object itself to identify potentially discernible characteristics that maybe used for metadata classification. The object type(s) are determined after the automated system has completed and an accounting of the different information object types is made. The metadata and types of metadata descriptors and their values are identified (**1904**) based upon properties associated with the information objects which is then structured. Based upon the determined object types metadata schema templates or metadata schema structure definition files which are similar to the identified object types can be identified (**1906**) from the identified metadata schema templates an analysis (**1908**) can be performed against the identified metadata and types of information objects to generate a metadata schema (**1910**).

During analysis of the metadata schema templates identification of schema structures which are bounded by previously predefined schema structure constraints is performed, which has the greatest degree of confidence to encompass the identified metadata, based on for example the type of information object, the number of metadata descriptors discernable from the object, similarity of the descriptors in terms of size, values, order, dependencies or value constraints. For example the constraints may be items such as a defined number of metadata fields that may be defined within the schema, a best fit to the identified metadata of all of the information objects or maximize the population objects that can be classified versus schema complexity. The metadata schema templates may be applicable to a particular information object type or may contain views and be applicable to multiple information object types.

The generation of the schema may include constraints and metadata descriptor attributes and values, language labels to metadata items for the different languages that need to be supported and provide any "Human Friendly" text labels for the automatically generated ValueIDs, configuration and references to dynamic value providers that may be required based on the information object types analyzed. The dynamic value providers may be used to gather metadata classification levels or provide a human defined list of values for certain metadata descriptors, logic expressions can then be from the constraints that are imposed on the metadata descriptors or from the intrinsic understanding that certain metadata descriptor values are not applicable or available based on the selection of previous metadata descriptors, views of schema based on the results of the determined information object types and the most relative schema views are assigned to appropriate information objects. In generation of the schema commonly used selections based on the templates or commonality of the attributes of the information objects can be defined to provide an easy way for end users to quickly set a views metadata descriptor values to predefined values based on the analysis performed of the stored information objects. Security policies may also be generated based upon are then defined based the analysis of the information object stored and provides the system which branches of the schema may need additional authentication based on the level of sensitivity in the metadata descriptor or their values. Additional security policies may be defined that only users or systems with certain security attributes can access this schema and associated views.

The generated schema may then be validated against a sample population of information object types to ensure that constraints have been met (**1914**). If the determined schema does not meet the constraints, the schema generation process maybe repeated until an acceptable schema is generated. Alternatively, the best fit schema maybe presented with metrics identifying compliance or non compliance of that schema and information objects which do not fit the schema model. The schema and/or metadata descriptors then may be signed and/or encrypted when stored (**1916**) to provide confidentiality and trust in the autonomously generated schema. The schema can then be made available to schema consumers or used by the intelligent system to classify the information objects identified. For example the intelligent system may then process the information objects that where initially analyzed and generate metadata conforming to the previously generated schema (**1918**). Additionally the metadata schema maybe applied against one or more information object stores that have been identified being similar to or compatible with the generated metadata schema. The metadata for each of the information objects can then be stored (**1920**). If processing of the information objects is performed by the intelligent system classification exceptions maybe identified and provided to the metadata schema generation process to further refine the schema either in subsequent interactions or in a refinement process.

FIG. **20** is a flowchart of a method of publishing a metadata schema. The completed schema is retrieved (**2002**) from the schema object store using schema builder API **310**. The location of schema access point is retrieved (**2004**) from configuration information for schema design and management **214**. Knowing schema access point location schema and deployment instructions can be provided (**2006**) to the schema access point with calls to schema publisher and deployment API **304**. schema access point makes published schema available to clients (**2008**) by using the schema access manager **404** to store the schema in schema data store **402**.

FIG. **21** is a flowchart of a method of schema client interaction with a schema access point for retrieval of schema(s) and view(s) via client I/O manager API produce a request (**2102**) for creating metadata on an information object is processed through schema client **206**. If there is a valid cached response available as determined by client i/o manager **210** by referencing off-line schema cache **510**, (YES at **2104**), the valid cached response is returned to schema client **206** for the originating client. If there was not a valid cached response in off-line schema cache **510** (NO at **2104**) then a request is sent to the schema access point **212** (**2108**) by client I/O manager **210**. If the client request is not authorized as determined by policy services **406** of schema access point **212** to schema access manager **404**, (NO at **2110**), a not authorized response is returned (**2112**) from policy services **406** then schema access point **212** returns to client i/o manager API **210** and in turn to schema client **206** that the request for schema was not authorized. If the request was authorized by **406** policy services (YES at **2110**) then the relevant schema views are received (**2114**) by schema access manager **404** requesting the appropriate schema from schema data store **402** and is returned to schema access point **212** to client I/O manager API **210** and the cache is updated (**2116**) with schema views if the result is cacheable into **510** off-line schema cache.

FIG. **22** is a flowchart of a method of adding metadata to an information object. The type of information object is determined (**2202**) through schema client **206** calling the object i/o manager **208** to access the information object **708** and passes it to schema client **206** for selection of schema view object **608**. If there is a view for this type of information object (YES at **2204**) the view is retrieved from off-line schema cache **510** (**2208**) and if not found in cache then an additional check is done with schema access point **212** to retrieve any matching views for schema view object **608**. If there was no defined view (NO at **2204**) for the information object **708** then the default view is used (**2206**). If a view was found for the associated information object **708**, it is retrieved (**2208**) from off-line schema cache **510** even if the schema access point **212** returned the view since client i/o manager api **210** would add the result of the request to off-line schema cache **510**. Favourites are retrieved (**2210**) based on view is available through schema access point **212** referring to policy server **406** if favourites are defined for that view. Dynamic values in the schema are then resolved (**2212**) and added to the schema view by schema access point **212** calling schema access manager **404** to reference the right dynamic value provider **412**. The schema view and associated favourites are then displayed (**2214**) to the user via 3rd party applications. When favourite selections are received from a user (YES at **2216**) the dynamic values **226** are validated as dictated by policy (**2226**). If the user does not select favourites (NO at **2216**) then pre-set defaulted values (**2218**) for the schema view is done in 3rd party applications **202** or user control **204**. Limit values are presented **2220** by the conditionality requirements in the schema view is done once the pre-set values are added to the view since conditionality may have been evaluated based on a pre-set value.

Authentication is performed (**2222**) for metadata fields having an authentication trigger is done if a metadata descriptor requires authentication to evaluate. This evaluation is done through schema access point **212** by policy services **406**. If the authentication was successful, then additional metadata descriptors are provided for fulfilment and value input is received (**2224**) for metadata fields after all required metadata descriptors are provided values and any optional metadata descriptors are provided with values. Dynamic values are validated (**2226**) as dictated by policy requires a call to schema access point **212** and in turn policy services **406** specifies which dynamic value providers require validation that the previously provided values are still valid. If validation is required, schema access manager **404** makes requests to dynamic value providers **412** for the latest values. If the values match then no further action is required. If they do not match then the process returns to present schema view (**2214**) and associated favourites along with an appropriate error message. Metadata values are stored (**2228**) once all the conditions are satisfied and schema client **206** calls the object i/o manager API **208** for storage of the metadata associated with **708** information object via metadata i/o plug-in manager **704** and the metadata plug-ins **706**.

FIG. **23** is a flowchart of a method of reading metadata from an information object. The information object is identified (**2302**) from which metadata is to be read. The type of information object is determined (**2304**) through schema client **206** calling the object i/o manager **208** to access the information object **708** and passes it to schema client **206** for selection of schema view object **608**. The schema view and interoperabilities are retrieved (**2306**) for the collection of metadata values is done by schema client **206** passing schema view object **608** to client i/o manager API **210** and requesting the view from off-line schema cache **510** and if not found in cache then an additional check is done with schema access point **212** to retrieve any matching views for schema view object **608**. Any required collection and reconciling of interoperability providers is done through schema client **206**. If metadata values are retrieved based on interoperabilities (YES at **2308**), the values are retrieved and the schema view instance is assembled in accordance with the interoperabilities combining rules (**2310**) is done by schema client **206**. The schema view instance is provided (**2312**) to the client and comes from schema client **206** to 3rd party applications API **202** or user control **204**. If no metadata value are to be retrieved based on interoperabilities (NO at **2308**) the schema view instance is provided to the client (**2312**).

FIG. **24** is a flowchart of a method of updating metadata for an information object. Portions of the schema view that are updateable based on policy are determined (**2402**). The schema access point **212** requests a policy decision on the updateable portions of the view associated with the information object **708** from policy services **406**. Schema view items that are not updateable are marked as read only (**2404**). Schema access point **212** passes the updated view through the client I/O manager API **210** to the schema client **206** and onto the requesting end client. Favourites are retrieved (**2406**) based on selected views that do not conflict with read only metadata is done through schema access point **212** referring to policy server **406** if favourites are defined for that view. The schema view and available favourites are displayed (**2408**) via 3rd party applications **802** or to **202**. If favourite selections are not received (NO at **2410**), the default value for the schema view is determined (**2412**). The values for selection

limited by the conditionality requirements are displayed (**2414**) in the schema view via 3rd party API or user control **204**. If conditionality is a requirement in the schema view, it is done once the display values for selection are added to the view since conditionality may have been evaluated based on a display values for selection. Input for values is received (**2416**) from 3rd party API **802** or to **202**. If recent favourite selection is made by the user (YES **2410**) the metadata set is completed (**2418**) through schema client **206**. Metadata is added to the Information object **708** (**2420**) by schema client **206** calling the object I/O manager API **208** for storage of the metadata associated with information object **708** via metadata I/O plug-in manager **704** and the metadata plugins **706**.

FIG. **25** is a flowchart of a method of deleting metadata from an information object. The information object from which metadata is to be deleted is identified (**2502**). The type of information object is determined (**2504**) through schema client **206** calling the object I/O manager **208** to access the information object **708** and passes it to schema client **206** for selection of schema view object **608**. The schema view associated with the information object **708** is retrieved (**2506**) by schema client **206** passing schema view object **608** to client I/O manager API **210** and it requesting the view from off-line schema cache **510** and if not found in cache then an additional check is done with schema access point **212** to retrieve any matching views for schema view object **608**. The type of deletions are available according to policy is determined (**2508**). The client I/O manager API **212** makes a request to schema access **212** point for a policy server **406** decision via Schema access manager **404**. A set of deletions is created (**2510**) to be applied to the metadata of the information object is done with schema access manager **404** creating a reducing view based on the information objects view. The reducing view is passed from schema access point **212** to client I/O manager API **210** and onto the schema client **206**. The schema client **206** then reconciles the metadata reducing view with the current set of metadata values by applying the deletions to the metadata of the information object **708** (**2512**). Once the new set of metadata is determined, updating the metadata associated with the information object is accomplished by schema client **206** calls the object I/O manager API **208** for storage of the metadata associated with information object **708** via metadata I/O plug-in manager **704** and the metadata plug-ins **706**.

More particularly, for example, each of the one or more client computing devices, server computer, schema administrator, schema access point, schema client, external entity or dynamic value providers, can be any of a general purpose device such as a computer or a special purpose device such as a client, a server, etc. Any of these general or special purpose devices can include any suitable components such as a hardware processor (which can be a microprocessor, digital signal processor, a controller, etc.), memory, communication interfaces, display controllers, input devices, etc. For example, client computing device can be implemented as a personal computer, a personal data assistant (PDA), tablet computer, a portable email device, a multimedia terminal, a mobile telephone, a set-top box, a television, etc.

In some embodiments, any suitable computer readable media can be used for storing instructions for performing the processes described herein. For example, in some embodiments, computer readable media can be transitory or non-transitory. For example, non-transitory computer readable media can include media such as magnetic media (such as hard disks, floppy disks, etc.), optical media (such as compact discs, digital video discs, Blu-ray discs, etc.), semiconductor media (such as flash memory, electrically programmable read only memory (EPROM), electrically erasable programmable read only memory (EEPROM), etc.), any suitable media that is not fleeting or devoid of any semblance of permanence during transmission, and/or any suitable tangible media. As another example, transitory computer readable media can include signals on networks, in wires, conductors, optical fibers, circuits, any suitable media that is fleeting and devoid of any semblance of permanence during transmission, and/or any suitable intangible media.

Although the description discloses example methods and apparatus including, among other components, software executed on hardware, it should be noted that such methods and apparatus are merely illustrative and should not be considered as limiting. For example, it is contemplated that any or all of these hardware and software components could be embodied exclusively in hardware, exclusively in software, exclusively in firmware, or in any combination of hardware, software, and/or firmware. Accordingly, while the following describes example methods and apparatus, persons having ordinary skill in the art will readily appreciate that the examples provided are not the only way to implement such methods and apparatus.

The invention claimed is:

**1**. A method of metadata management that is executed by a processor, the method comprising:

determining metadata descriptors and metadata constraints of one or more types of information objects stored in a memory;

determining a metadata schema structure definition comprising a plurality of the metadata descriptors and relationships between one or more of the plurality of the metadata descriptors and one or more of the metadata constraints, and further determining a metadata schema to be used to define metadata for the one or more types of information objects;

determining an interoperability definition for one or more of: the plurality of the metadata descriptors; metadata values associated with the plurality of the metadata descriptors; and a serialization definition for generating an interoperability mapping based upon the one or more types of information objects and the metadata schema structure definition to enable interchange between one or more external schema formats;

generating the metadata schema in a structured definition language comprising:

the plurality of the metadata descriptors and the metadata values with the metadata constraints;

the interoperability mapping; and

one or more views, each view defining a subset of the metadata schema applicable to the one or more types of information objects; and

storing the metadata schema to the memory,

wherein determining the metadata schema structure definition comprises retrieving one or more schema structure definition templates, each associated with the one or more types of information objects and determined to have properties similar to the plurality of the metadata descriptors and the metadata constraints of the one or more types of information objects, the one or more schema structure definition templates adapted to create the metadata schema structure definition to map the plurality of the metadata descriptors and the metadata constraints.

**2**. The method of claim **1** wherein generating the metadata schema comprises validating the metadata schema against the metadata constraints, wherein the metadata constraints define

logical constraints among the metadata descriptors, metadata descriptor types, and the metadata values.

**3**. The method of claim **1** wherein the interoperability mapping is retrieved by clients to enable bi-direction exchange of metadata and formatting of information objects that have had metadata applied to them using the metadata schema and an external entity requiring an external metadata schema format.

**4**. The method of claim **1** further comprising determining authentication requirements to authorize presentation of a subset of the plurality of the metadata descriptors or the metadata values to a client computing device utilizing the metadata schema by accessing an identity provider for providing access permissions associated with a user of the client computing device.

**5**. The method of claim **1** wherein one or more of the metadata descriptors are conditionally bound to a selection of dependent metadata descriptors and associated metadata values.

**6**. The method of claim **1** wherein the metadata constraints define user selections of the metadata values defined within the metadata schema.

**7**. The method of claim **1** wherein generating the metadata schema structure definition comprises defining a cardinality of one or more of the plurality of the metadata descriptors and the metadata values.

**8**. The method of claim **1** wherein the structured definition language is defined in extensible markup language (XML).

**9**. The method of claim **8** wherein information objects are defined as computer readable electronic data files stored in a memory.

**10**. The method of claim **1** wherein the schema structure definition templates are selected as providing schema structures or views which are bounded by previously predefined schema structure constraints that have a greatest degree of confidence to encompass metadata of one or more information objects.

**11**. The method of claim **1** wherein determining the metadata descriptors and the metadata constraints of the one or more types of information objects is performed by analyzing a subset of information objects stored in the memory.

**12**. The method of claim **1** wherein the metadata schema is validated against a sample population of information object types to ensure that constraints have been met, wherein if the metadata schema does not meet the constraints, the metadata schema is re-generated until an acceptable metadata schema that meets the constraints is generated.

**13**. The method of claim **1** wherein the metadata schema is defined by performing a best-fit of the metadata schema structure definition against the one or more schema structure definition templates.

**14**. The method of claim **13** wherein a best-fit metadata schema structure definition is presented with metrics identifying compliance or non-compliance of the metadata schema and information objects which do not fit the metadata schema structure definition.

**15**. The method of claim **1** wherein the metadata schema identifies at least one dynamic value provider associated with one of the metadata descriptors, wherein metadata values associated with the one of the metadata descriptors are provided by the dynamic value provider.

**16**. The method of claim **15** wherein the metadata schema enables a client using the metadata schema to retrieve a value from the at least one dynamic value provider upon processing the information object.

**17**. The method of claim **1** further comprising:

determining an information object type of an information object;

receiving the metadata schema in response to a request based upon the information object type;

parsing a received plurality of metadata descriptors and metadata constraints defined in the metadata schema to determine valid metadata values for the information object type;

determining metadata values to be associated with the received metadata descriptors from the information object; and

storing the determined metadata values associated with the information object.

**18**. The method of claim **1** wherein the generated metadata schema is partially or fully encrypted or signed.

**19**. The method of claim **1** wherein the interoperability mapping includes a mapping with external schema value providers.

**20**. A non-transitory computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management, the method comprising:

determining metadata descriptors and metadata constraints of one or more types of information objects stored in a memory;

determining a metadata schema structure definition comprising a plurality of the metadata descriptors and relationships between one or more of the plurality of the metadata descriptors and one or more of the metadata constraints, and further determining a metadata schema to be used to define metadata for the one or more types of information objects;

determining an interoperability definition for one or more of: the plurality of the metadata descriptors; metadata values associated with the plurality of the metadata descriptors; and a serialization definition for generating an interoperability mapping based upon the one or more types of information objects and the metadata schema structure definition to enable interchange between one or more external schema formats;

generating the metadata schema in a structured definition language comprising:

the plurality of the metadata descriptors and the metadata values with the metadata constraints;

the interoperability mapping; and

one or more views, each view defining a subset of the metadata schema applicable to the one or more types of information objects; and

storing the metadata schema to the memory,

wherein determining the metadata schema structure definition comprises retrieving one or more schema structure definition templates, each associated with the one or more types of information objects and determined to have properties similar to the plurality of the metadata descriptors and the metadata constraints of the one or more types of information objects, the one or more schema structure definition templates adapted to create the metadata schema structure definition to map the plurality of the metadata descriptors and the metadata constraints.

**21**. A method of metadata management stored in a non-transitory computer readable memory, the method executed by a processor coupled to the memory, the method comprising:

determining an information object type of an information object;

receiving a metadata schema in response to a request based upon the determined information object type, the metadata schema comprising:

a plurality of metadata descriptors and metadata constraints associated with the determined information object;

an interoperability mapping based upon the information object type and a metadata structure definition to enable interchange between one or more external schema formats; and

one or more views, each of the one or more views defining a subset of the metadata schema applicable to the determined information object type;

parsing the received plurality of metadata descriptors, the received metadata constraints, the received interoperability mapping and the received one or more views included in the metadata schema to determine valid metadata values for the information object type;

determining interoperability parameters associated with the information object type, the interoperability parameters determined from the interoperability mapping providing a mapping of metadata values, metadata descriptors and structure between the metadata schema and an external entity;

determining metadata values to be associated with the received plurality of metadata descriptors from the determined information object and in conformity with the metadata schema and the interoperability parameters; and

storing the determined metadata values for the information object.

**22**. The method of claim **21** further comprising:

retrieving a policy document associated with the metadata schema; and

determining interoperability rules from the policy document for determining which one or more of a plurality of differing values are to be selected from the external entity to be associated with the metadata descriptors.

**23**. The method of claim **21** wherein the interoperability parameters define a data storage location for storing the metadata values.

**24**. The method of claim **22** wherein if there are multiple interoperability rules and multiple metadata values, the interoperability rules and the metadata values associated with an external entity that is validly signed are authoritative for selecting metadata values from the multiple metadata values to be associated with a metadata descriptor.

**25**. The method of claim **24** wherein, when the multiple interoperability rules provide valid values from a plurality of valid signed external entities, a metadata value for each of the interoperability rules is weighted based upon one or more signature characteristics associated with the respective external entity to select a metadata value to be associated with a metadata descriptor.

**26**. The method of claim **21** wherein the metadata schema further defines one or more relationships between multiple metadata names and multiple metadata values.

**27**. The method of claim **21** wherein determining interoperability parameters comprises:

validating determined metadata values by associated ranges and constraints defined in the metadata schema.

**28**. The method of claim **21** wherein the metadata schema further defines one or more conditional relationships and associated ranges.

**29**. The method of claim **21** further comprising authenticating a user by a defined authentication method for any metadata descriptors and/or values that require authorization for modification or viewing by the user.

**30**. The method of claim **21** wherein determining metadata values from the information object comprises retrieving stored metadata associated with the information object and formatting the retrieved metadata to the metadata schema.

**31**. The method of claim **21** wherein determining metadata values comprises communicating with a dynamic value provider identified in the metadata schema or associated with the information object and receiving a value to be associated with the plurality of metadata descriptors.

**32**. The method of claim **21** wherein determining metadata values comprises determining values based on metadata values derived from content of the information object or a context of how the information object is stored.

**33**. The method of claim **21** further comprising determining a language to display for the metadata descriptors and the metadata values based on a determined language of a consuming client computing device.

**34**. The method of claim **21** wherein the received metadata schema is partially or fully encrypted or signed.

**35**. The method of claim **21** wherein the interoperability mapping includes a mapping with external schema value providers.

**36**. A non-transitory computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management, the method comprising:

determining an information object type of an information object;

receiving a metadata schema in response to a request based upon the determined information object type, the metadata schema comprising:

a plurality of metadata descriptors and metadata constraints associated with the determined information object type;

interoperability mappings based upon the information object type of the information object and a metadata structure definition to enable interchange between one or more external schema formats; and

one or more views, each of the one or more views defining a subset of the metadata schema applicable to the determined information object type;

parsing the received plurality of metadata descriptors, the received metadata constraints, the received interoperability mappings and the received one or more views included in the metadata schema to determine valid metadata values for the information object type;

determining interoperability parameters associated with the information object type, the interoperability parameters determined from the interoperability mappings providing a mapping of metadata values, metadata descriptors and structure between the metadata schema and an external entity;

determining metadata values to be associated with the received plurality of metadata descriptors from the determined information object and in conformity with the metadata schema and the interoperability parameters; and

storing the determined metadata values for the information object.

**37**. A method of metadata management at a schema access point executed by a processor, the method comprising:

receiving a request from a client computing device identifying an information object type;

determining an identity associated with the client computing device and associated security and configuration parameters;

determining applicable metadata schema in a structured definition language for the information object type from a plurality of metadata schema and the determined identity, the applicable metadata schema comprising;

a plurality of metadata descriptors and metadata constraints associated with an information object of the information object type;

interoperability mappings based upon the information object type and a metadata structure definition to enable interchange between one or more external schema formats; and

one or more views, each of the one or more views defining a subset of the metadata schema applicable to the information object type;

generating a client metadata schema using the applicable metadata schema; and

sending the client metadata schema to the client computing device for application of the client metadata schema to information objects of the information object type.

**38**. The method of claim **37** further comprising modifying the interoperability mappings included in the applicable metadata schema based upon the identity associated with the client computing device and enabling a bi-direction exchange of metadata and formatting of the information object between the applicable metadata schema and an external entity.

**39**. The method of claim **37** wherein, when the interoperability mappings define valid values from a plurality of valid signed sources, the value for each of the interoperability mappings is weighted based upon one or more signature characteristics to select a value to be associated with a metadata descriptor.

**40**. The method of claim **37** wherein the structured definition language is defined in extensible markup language (XML).

**41**. The method of claim **37** further comprising determining authentication requirements to authorize presentation of a subset of the plurality of metadata descriptors or metadata values to a client computing device utilizing the generated metadata schema by accessing an identity provider for providing access permissions associated with a user of the client computing device.

**42**. The method of claim **37** wherein one or more of the plurality of metadata descriptors are defined in the metadata structure definition as being conditionally bound to a selection of dependent metadata descriptors and associated values.

**43**. The method of claim **41** wherein determining the authentication requirements comprises:

retrieving a policy decision associated with the generated metadata schema and the identity of the client computing device; and

determining metadata descriptors or metadata values to be provided in compliance with the policy decision to the client computing device.

**44**. The method of claim **43** further comprising determining interoperability rules from the policy decision for determining which of a plurality of differing values are to be selected from an external entity to be associated with the metadata descriptors.

**45**. The method of claim **37** further comprising determining a location of a dynamic value provider and modifying the metadata schema to identify the location.

**46**. The method of claim **37** further comprising determining a location of a dynamic value provider and modifying the metadata schema to identify a value provided by the dynamic value provider.

**47**. The method of claim **37** wherein determining the identity associated with the client computing device is performed through a directory service coupled to the schema access point.

**48**. The method of claim **37** wherein the generated client metadata schema is partially or fully encrypted or signed.

**49**. The method of claim **37** wherein at least one of the interoperability mappings includes a mapping with external schema value providers.

**50**. A non-transitory computer-readable medium containing computer-executable instructions that, when executed by a processor, cause the processor to perform a method for metadata management at a schema access point, the method comprising:

receiving a request from a client computing device identifying an information object type;

determining an identity associated with the client computing device;

determining applicable metadata schema in a structured definition language for the information object type from a plurality of metadata schema and the determined identity;

generating a client metadata schema using the applicable metadata schema, the client metadata schema comprising;

a plurality of metadata descriptors and metadata constraints associated with an information object of the information object type;

interoperability mappings based upon the information object type and a metadata structure definition to enable interchange between one or more external schema formats; and

one or more views, each of the one or more views defining a subset of the metadata schema applicable to the information object type; and

sending the client metadata schema to the client computing device for application of the client metadata schema to information objects of the information object type.

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